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EDITORIAL

Bombs and Blackouts

WITH cannon crying for copper, airplanes for aluminum, and munitions manufacture for electric energy, this may not be the best time to urge the construction of new rural electric lines and the connection of added loads. Even so, with the loss of labor from the farm and the need for increased food production, extension may be wise where electricity does definitely make farms and farmers more productive.

But much more critical is the protection of agricultural activity already dependent on electricity, and especially that contingent on continuity of service. Large poultry and egg production are demanded, and both depend in considerable measure on electric light and heat. Laying houses suddenly darkened, and brooders gone cold, would take a toll not to be measured by the hours of interruption. Saboteurs are smart enough to see the havoc they could work by blasting rural substations or other vital links between generator and incubator or milling machine, locker plant or creamery.

It is not for the layman to suggest detailed methods, but he can properly propose the principle of interconnection or other means of duplicating sources of energy, and of carrying such protection as close as may be to the individual farm. Materials for such strategic linkages may properly be released from the nation's limited resources. All agricultural engineers, simply because they know the part played by electricity for food producers, may well lend the weight of their influence in support of such plans as may be proposed by their colleagues in the rural electric wing of the profession.

Before this war is much older, blackouts promise to be the order of the day—or night. It is not too early for farm structures and rural electric engineers to go into a huddle on how to provide prompt blackouts of farm homes, barns, and poultry houses. For the latter, at least in vulnerable areas, blackout protection probably should be continuous.

Profit the Yardstick

HOWEVER plausible may be the slogan, "Take the profit out of war", for purposes of political oratory, it is a poor principle—possibly a fatal fallacy—for a nation whose destiny depends on a war of production. Profit may not be noble as a motive, but it stands as the most reliable measure and the most potent stimulus of efficient production.

Whether figured against competitive bids, ordnance department estimates, or pre-existing cost levels, the road to profit is the more economical use of materials and manpower, multiplied by the speed of production. Right now this nation needs to make materials and man power go farther—much farther—and above all it needs speed.

Profit as the method and measure of speed and economy costs but little. If we are correctly informed, a corporation of any consequence already pays federal income and surtax of more than 30 per cent on its normal earnings, with 55 per cent proposed for next year. What are called excess profits are now taxed from 35 to 60 per cent. When those rare profits are recaptured to the tune of some 70 per cent, it leaves but a passing premium for the services of scientific and production genius, in the case of war goods, and on civilian supplies—still the greater part of our production—profit taxes are a bonanza for a federal treasury trying to finance the most costly war of all time.

Because they make materials and man power go farther and faster, engineers are prime producers of profits, the social blessings and national security which spring from profits. Because profits today point the way to savings tomorrow, engineers wield the most potent tool for economy amid the frightful wastes of war. Let them use that tool to the full, and proclaim it proudly.

To Ag Engineers

MY message to each and every agricultural engineer in this hour of our country's great need, is that he feel strongly within himself that he is important in the winning of the war, and in trying to shape the kind of a country he wants to live in when the war is over.

I know there is a tendency for the average individual to think that he is not important—that he is too infinitesimal a unit in the whole machine to have any effect upon it. A tractor would have a difficult time trying to run without contact points and valve springs. I have sufficient confidence in the intelligence and common sense of agricultural engineers to know that they can be contact points and valve springs. I do not mean that the points should arc and the springs snap out of place. They are a necessary part of the machine, and they must be ready to spark or push when sparking and pushing is needed.

GEO. W. KABLE
President, A.S.A.E.

Geared to War Effort

AS rapidly as may be, the activities of the American Society of Agricultural Engineers will be more definitely geared to the combined efforts of the United Nations to win the second World War.

Responsible leaders recognize that the production of food, feed, and fiber is second to none as an essential part of the all-out war effort. Moreover, the demand for expansion of such production is growing, and that means expanding responsibilities for agricultural engineers.

In the application of engineering to the many problems of field production, processing, storage, conservation, etc., as related to agricultural production as a whole, it is not a case of bringing the agricultural engineer into the picture—he is already very much in it. It fact, since the first world war especially, the agricultural engineer has made great strides in applying engineering techniques to agricultural requirements and processes; indeed his achievements rank with those of other engineering groups in their respective fields. So it may be said that the work of agricultural engineers, in their everyday jobs, constitutes a definite, direct contribution to the war effort. However, the war will tremendously enhance their opportunity to serve both agriculture and their country.

The strong forte of the agricultural engineer is in increasing the efficiency of labor in farming operations by means of improved management, machines, structures, and instead of being made to feel that he is unpopular in showing how it is possible for fewer people on farms to produce more at lower cost and therefore at greater profit to themselves, the engineer will now have the green light in rendering such assistance as his particular talents make possible in speeding up agricultural production and in providing for adequate shelter, storage, and other facilities for all essential farm commodities.

The A.S.A.E. will direct its activities toward giving agricultural engineers every possible help in connection with their contribution to the war effort.

AGRICULTURAL ENGINEERING

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Land, Labor, Machines—Key Factors in Wartime Agriculture

By Frank J. Zink

MEMBER A.S.A.E.

IN 1942 the job of the United States farmer is to produce more food than has even been produced before in this country. Farmers now have the green light to drive ahead with discretion, after having proceeded on the amber light for a number of years. The destination as set up by Secretary of Agriculture Wickard is clear for 1942. The only control is for the purpose of obtaining balance, so that we will not have all wheat and cotton jeans and not enough meat, milk, and vegetable oil crops. The state and county defense boards serve as the guides to increases or decreases of crops. It is the duty in the war effort of every farmer to inform himself what is expected of him as a production manager in agriculture.

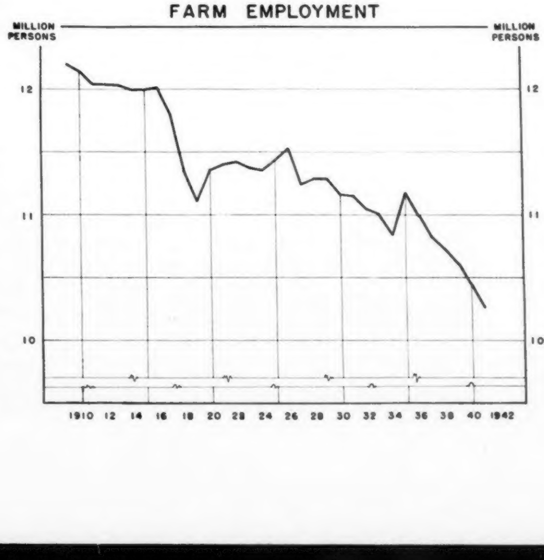
The term "production manager" is used in the sense that the farm is a factory. All farms in the country, over six million of them, are factories. Each has a production manager. Each is a family unit, perhaps in fully ninety-eight of every one hundred cases. Many, the majority, have no employed personnel. Thus the skill of each farm manager along with the skill of each member of his family is applied to the family acres.

Only three major things add up to equal food. They are (1) these family acres, the land; (2) the farm family, the labor; (3) the production tools, the farm machines. The raw materials are taken directly from the sources on the farm itself with a few supplementary exceptions in each production unit.

According to reports, there are only about 200,000 manufacturing firms in the country. They, too, are manned by production managers, but there are only a few as compared to the number of managers in agriculture. They, too, use labor. They use materials, but in their case the materials must be brought in from mines, mills, and other factories. They use production tools all of which process materials in a dead, inert condition. These production tools may process the materials at the rate of 24 hours per day in a 365-day year.

Agriculture, on the other hand, uses production tools, all of which must be keyed to living organic substances, each of which has some life cycle. Thus the life cycles determine the time and the duration of usage of the farm machines all the way from soil fitting through planting, cultivation, insect control, harvesting, processing the crops, and then through feeding the crops to livestock for producing animal products.

FARM EMPLOYMENT



Article prepared especially for AGRICULTURAL ENGINEERING. Author: Agricultural engineer, Farm Equipment Institute.

There are many people who do not recognize these life-cycle differences between agricultural production with machines and factory production with machines. Also, in agricultural production, when weather conditions are disturbed, the times and usages of machines are also disturbed. Everyone having to do with planning the supplies for farm production, must take into full account these basic differences together with the basic differences in management of factory and farm.

To increase factory output besides installing more efficient machines, new employees can be trained and 16 and 24-hour day operations inaugurated. This is not true in agriculture. More efficient machines may be used to decrease farm labor requirements. Better management skill must be used to increase land productivity and animal production efficiencies. Unlike the factory, where doubling or tripling output may be a reality when needed, the farm can increse only a few per cent in each individual case.

The family acres, representing the land portion of our farms, are limited. The 1942 agricultural program is not intended to expand and add more acres, especially this year.

On a per capita basis, since 1910 each person of the United States has used the products of no more than 2.2 acres of harvested crops, or no less than 1.8 acres of harvested crops for supplying the needs of food, fiber, and tobacco. In this thirty-year period, the average per capita acres of such crops harvested stands at exactly 2.0 acres. What has been learned to improve production efficiency on a per acre basis has about kept pace with declines of land productivity.

To feed 10 million more people in addition to our own population under the lend-lease program, the farm manager, on whom the responsibility rests, has but two courses open to him — either be more efficient by at least 8 to 10 per cent, or bring more land into the production of food and fiber crops. Every acre of crop land taken out of unwanted production must be used to its highest efficiency in desired production. The sensible course and obviously the most feasible course open to each farm manager is to increase production efficiency. The knowledge is

available to do the job. Those farmers now using best known practices probably are near the peak of their production efficiency. Therefore, on the less efficient farmer rests a greater responsibility than on the more efficient.

Whatever happens, we must this year avoid permitting any land to go out of production.

The population has increased while at the same time the number of persons employed in agriculture has decreased. This is not alarming. The only cause for reflection is the increased rate of persons leaving agriculture during war periods.

The use of labor is the principal point of improved agricultural production efficiency. However, for labor to improve its efficiency in agriculture, it must have machinery geared with it. Any regression to less efficient machines or any less machinery means greater amounts of labor will be required.

In World War I, there were over a million fewer persons employed on the farms at the end of the war than at the beginning. In 1941, there were 462,000 fewer employed than during the average of the 5-year period, 1936 through 1940. The agricultural program as revised to January 16, 1942, will require this year the productive capacity of 605,000 more men than were required during the average of this same 5-year period. Thus we begin this year short the time available from 1,067,000 persons for the job scheduled. The labor of persons who leave agriculture in 1942 must also be replaced.

Farm labor, therefore, is the real hurdle in our gigantic food-for-freedom effort. It represents a concrete problem on about one farm in five for the United States.

Obviously the answer to the needed farm labor for the added productive effort, when not available from family or older or younger age groups, can only come either from working longer hours, or the extension of the production effort by farm machines. A great many farmers are near to the limit of their use of time. It is highly difficult for any efficient farmer practicing diversified agriculture to increase materially the number of hours he works. Therefore, because the efficient farmer cannot expand greatly by increasing the length of work days, the greater share of the responsibility rests upon those farmers who have surplus time available.

Farm cost accounts in New York state have recorded work years of an average of 2,995 hours. This is equivalent of a 59-hour work week. The average work year for the country is around 2,500 hours on farms. This is an overall average of 50 hours per week. Naturally peak seasons of work on farms, especially during harvest periods, require many 65 to 75-hour weeks.

Farm machinery purchases tend to be normal when the supply of farm labor continues on a steady normal decline. However, just as soon as the supply of farm labor, as in this war period, is sharply decreased new demands for equipment begin to develop. At such times farmers strive to satisfy their needs for farm equipment irrespective of farm income or buying power. Farmers purchased machines in World War I to offset the loss of over a million persons employed. By doing this, they were able to continue to increase food production.

The supply of machines now on farms is below normal. The tendency is to increase the amount of machines on farms to compensate for the decreasing trend in the numbers of persons employed.

The farm machinery situation today, in this war period, is not comparable to earlier situations. In the late thirties, farmers purchased machinery for three reasons besides normal replacements of worn-out machines: (1) To balance the low rate of replacement during the depression years; (2) to replace workers lost from agriculture since 1935 to date, which now amounts to 905,000 persons, and which is about 9 per cent of the average number of persons employed in agriculture during 1941; and (3) to put into practice measures of improved agricultural efficiency coming from many sources, such as improved engineering design, changing agricultural practices, soil conservation, sanitary regulations for dairy and meat production, and livestock feeding efficiency, as well as for labor saving. The needs for equipment in these latter items of activity, including higher living standards, have carried demands for farm equipment far beyond the desire for machines to save labor.

What about the machinery supplies for 1942 to reach this increased food goal?

This has been a topic involving many months of discussion. Surveys both private and public have been made. Generally speaking, these quotas average around 80 to 85 per cent of the 1940 production, although for a few machines used chiefly in milk and oil seed production, the quotas are in excess of the 1940 figure. Quotas for attachments and parts are somewhat higher to offset the reduced supplies of the new machines in 1942.

It should be kept in mind that these are percentages of 1940 output. In 1941 the production of farm equipment was materially increased, due to the progressively increasing demand because of the serious farm labor situation and the inauguration of the program of the U. S. Department of Agriculture for increased food production.

Land, labor, and machines are the main factors of food production. We know exactly how much land, how much labor, and how much machinery there is available in 1942. It becomes the individual farmer's problem to study his own case very minutely, and by so doing increase the land efficiency, increase labor efficiency to offset men no longer available, and increase the efficiency and use of time-saving machinery to do the big job ahead.

Now as at no other time, the agricultural engineering profession has an opportunity to exert its influence, for here is a definite need for the knowledge of engineering efficiency combined with the undertaking of agricultural problems. Every agricultural engineer can make himself felt through intelligent cooperation with the movement for increased production through increased efficiency.

Some Engineering Phases of Grain Storage

By H. J. Barre and C. F. Kelly
MEMBER A.S.A.E. MEMBER A.S.A.E.

THIS paper discusses primarily the engineering phases of the more important problems of grain storage and of studies which have been conducted during the past two years by the Bureau of Agricultural Chemistry and Engineering (USDA) in cooperation with some of the state and other federal agencies. Reports covering a large part of the previous investigations of wheat and corn storage are published in the form of USDA circulars and articles in AGRICULTURAL ENGINEERING, a list of which is appended to this paper. Additional projects have been added within the last few years.

About two years ago, a Bankhead-Jones project on grain sorghum storage was initiated with a field station at Hays, Kansas. This is cooperative with the Bureau of Plant Industry, the Agricultural Marketing Service, and the Kansas Agricultural Experiment Station.

More recently a new project on methods of properly caring for grain in long-time storage was begun. The funds for this project are supplied by the Commodity Credit Corporation. Several federal and state agencies are cooperating, including the Commodity Credit Corporation, the Agricultural Adjustment Administration, the Bureau of Agricultural Chemistry and Engineering, the Bureau of Entomology and Plant Quarantine, the Bureau of Plant Industry, the Agricultural Marketing Service, and state agricultural experiment stations of North Dakota, Kansas, and Iowa. Regional headquarters are at Ames, Iowa, with field stations at Hutchinson, Kansas, and Jamestown, North Dakota.

Wheat Storage Studies. Although storage studies have been conducted during the last several years at four field stations under a Bankhead-Jones project, the problems of the storage of wheat over periods of three to five years have not been covered completely by this project. In anticipation that new problems would be encountered by long-time storage on farms, the Commodity Credit Corporation has supplied funds for careful planning and detailed observations in connection with two experimental wheat storage sites. One of the sites selected is at Hutchinson, Kansas, which is in the hard winter wheat area, and the other is in the spring wheat area at Jamestown, North Dakota. The Corporation has also made available steel bins and wheat in its possession. The erection and filling of these bins, involving the erection of about 340 bins and the placing in storage of about 600,000 bu of wheat, were begun in June 1941 at Hutchinson and completed the latter part of August. At Jamestown, the work of erection and filling was about a month later.

The studies at each of the two locations consist of four parts or divisions, namely, (1) management, (2) floor, (3) ventilation, and (4) special studies. The field work, including the procuring of samples, observing temperatures, fumigation of bins, and analysis of data, is a joint obligation of the Bureau of Agricultural Chemistry and Engineering and the Bureau of Entomology and Plant Quarantine. The Agricultural Marketing Service makes all determinations of grade and all fat acidity, protein, germination, and milling and baking tests. The Agricultural Adjustment Administration through its county associations in the counties in which the two sites are located, makes all arrangements for obtaining the wheat and takes care of many other matters incidental to the project. The state agricultural experiment stations of Kansas and North Dakota cooperate by providing any assistance needed and by furnishing equipment and technical advice. A brief discription of each part of the studies follows:

Management Studies. These are designed to permit the evaluation of different types of treatment and conditioning practices as well as to determine what types of structures will be most effective and economical in keeping wheat in good condition over a period of several years. The influence of high dockage and of low test weight on the ability to keep wheat in good condition is also to be determined. Management studies apply to about three-fourths of the wheat in storage at each site and the greatest amount of effort is therefore extended in this direction. Table 1 gives the number, the size, and the types of bins and the kind of wheat to be placed in each group of bins and treatment to be applied or the conditioning practice to be followed at the Hutchinson site.

Essentially the same plan is followed by Jamestown, except that large bins are not used, and Durum wheat is used as well as hard spring wheat. Also a few modifications are made in the treatments to fit the conditions of that area. The conditioning methods may be considered as

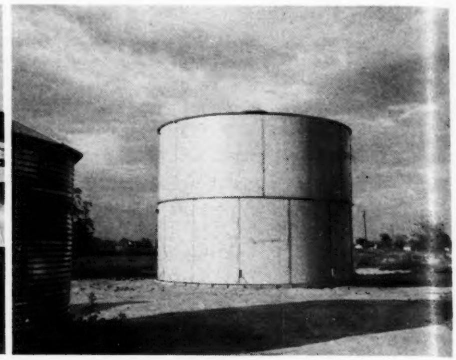
Paper presented December 3, 1941, at the fall meeting of the American Society of Agricultural Engineers at Chicago. Authors: Agricultural engineer, Farm Structures Research Division. Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture, and associate agricultural engineer, Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture, respectively.

TABLE 1. COMBINATIONS OF TREATMENT, TYPE OF WHEAT, VENTILATION, SIZE AND TYPE OF BINS IN MANAGEMENT STUDIES AT HUTCHINSON, KANSAS

		2740-bu bins					1000-bu bins	4000 to 5000-bu bins	
Treatment	Wheat type (1)	Tight floor and walls	Tight floor	Tight floor, walls, and roof	Solid L-tube	Perforated L-tube	Tight floor and walls	L-tube	Tight floor and walls
1 No treatment, no initial fumigation	(a)*	3							
Preventive									
2 No treatment after initial fumigation	(a)	3		3	2	2	2		
3 Oil spray of wheat surface, June and September	(a)	3			2	2	2		
4 Fumigation, June and September	(a)	3			2	2	2		
5 Turning in January	(a)	3			2	2	2		1
Curative									
6 Fumigation when necessary	(a)	3	2		2	2	2	1	1
	(b)**	3							
	(c)†	3							
7 Turning and cleaning when necessary	(a)	3	2				2		
8 Turning, cleaning, and fumigation when necessary	(a)	3					2		

*(a) Hard red winter wheat with typical grade factors.
**(b) Same as (a) except high dockage.
†(c) Same as (a) except low test weight.

Fig. 1 (Left) Part of the experimental wheat storage site at Hutchinson, Kans. There are a total of 166 bins. On the right are 1000-bu bins, on the left 2740-bu bins, and in the center is one of the 5000-bu bins. Nearly 300,000 bu of wheat have been placed in storage. A number of bins have been left empty for turning and cleaning purposes • Fig. 2



(Right) A 4500-bu bolted steel tank under observation at the Hutchinson wheat storage project. This bin represents an extreme in tightness of construction the advantages of which are to be evaluated from the standpoint of keeping grain in condition and keeping insects from reinfesting the wheat

being of two different groups or classes, namely, those which are preventive and those which are curative. Bins of three different sizes are used to learn what storage difficulties may be encountered and what the possibilities are for reducing the cost by increasing the size of bin. The large bins at Hutchinson have been supplied on a loan basis by several steel bin manufacturers in the interest of these studies.

Bins have been made with different degrees of tightness by caulking walls, floors, and even roofs, for the purpose of determining the merit of tightness for not only keeping out moisture but also for the control of insects. The 4500-bu bolted steel tank shown in Fig. 2 represents an extreme in tightness.

Both perforated and solid-walled, 18-in central tubes have been installed in a number of 2740-bu bins. The bottom of the tube is connected to outside air by a horizontal duct running from the center of the bin to the door. The tops of the tubes open into the space underneath the roof. The solid-walled tubes are intended to perform only the function of cooling the wheat. The perforated tubes permit a limited amount of aeration as well as cooling. It is planned to have the ventilators open during cold weather and closed during warm weather.

All of the wheat used for these studies is of the 1940 crop. The wheat at Jamestown had been stored for one year in surrounding country elevators and that at Hutchinson in local terminal elevators. In general, the wheat in all bins at each location runs about the same in moisture content and other grade factors; however, at both Hutchinson and Jamestown several bins are filled with low test weight wheat and several with high dockage wheat.

Samples for grade, milling and baking, fat acidity, germination and protein tests are being taken periodically and close watch is kept upon insect activity by the entomologists. Thermocouples are being installed in each bin, and it is planned to make temperature observations every two weeks. Complete records of cost of the various treatments, such as fumigation, turning, and cleaning are also being obtained, and we feel that from these data it will be possible to draw definite conclusions as to the best and most economical method of storing wheat in farm size structures.

Floor Studies. In view of the lack of information on floors suitable for grain bins, a total of 13 different types of floors and floor treatments are being observed at each station in 1000-bu bins. The different types are as follows:

1. Steel floor laid over earth fill
2. Same as No. 1 except gravel fill
3. Same as No. 1 except floor laid over hollow masonry blocks
4. Steel floor laid over wood joists set up off the ground
5. Concrete floor laid over earth fill
6. Same as No. 5 except gravel fill
7. Same as No. 5 except floor laid over hollow masonry blocks
8. Same as No. 5 except overlaid with a layer of moisture-proof paper
9. Same as No. 5 except overlaid with 1-in wood boards
10. Same as No. 5 except overlaid with both moisture-proof paper and 1-in boards
11. Same as No. 5 except asphalt applied hot and topped with 1-in concrete
12. Single wood floor set up off ground
13. Double wood floor set up off ground with layer of moisture-proof paper between.

Each of the types is studied in duplicate at both Jamestown and Hutchinson.

A special probe is being developed to permit taking samples of grain in contact with the floor without emptying the bin. In this way, continuous observation of the condition of the grain next to the floor can be made over an extended period.

Ventilation Studies. In view of the need for methods of conditioning damp wheat on farms, some of the more promising methods of bin ventilation are being tried at both bin sites in order to determine more nearly the limitations of each method. For example, at Hutchinson, the methods being tried are as follows:

Wind pressure cowl with central chamber	3 bins
Perforated floor with pressure cowl	2 bins
Mechanical ventilation (day only)	2 bins
Mechanical ventilation (continuous day and night)	2 bins
Check (no ventilation, floor and walls caulked)	3 bins

Only 1000-bu bins are being used for these studies. Wheat from the 1941 crop, with excess moisture, was placed in these bins. However, it was not possible to fill all bins with damp wheat of the same moisture content. At Hutchinson, tests on the mechanically ventilated and the check bins are already completed. These were filled with wheat of nearly the same moisture content ranging from 14.7 to 15.4 per cent. The wheat in the check bins went out of condition after less than two months storage. That

in the mechanically ventilated bins dried to a reasonably safe moisture content within two weeks.

Special Studies. Some of the bins at both Hutchinson and Jamestown are being used for special studies having to do largely with insect control by fumigation, by using insect repellent covers over the grain to prevent infestation from the outside, and by special turning and cleaning methods. The effect of different types of bin covers, such as water-proof paper and cotton bats, which are laid directly on the wheat, for controlling both insect infestation and moisture accumulation and redistribution, is being studied at both stations. Two bins with dome roofs of the type used on silos, but so reinforced as to resist the outward pressure of the grain when filled to within 4 ft of the top, were erected at Jamestown and are being tested for strength, weathertightness, ease of sampling and filling, and cost of storage per bushel. A bin painted white is being studied at Hutchinson to determine whether the wheat in the painted bin will average lower in temperature than that in the unpainted bin, and whether the difference in temperature will affect the wheat quality in any way.

Corn Storage Studies. Investigations relating to corn storage during the past two years have been in the form of (a) a field survey of farm storage of ear corn, (b) storage of both ear and shelled corn in experimental cribs and bins, and (c) observations of shelled corn in steel bins owned by the Commodity Credit Corporation. Under the new project being supported by the Commodity Credit Corporation, the observations of shelled corn in steel bins have been expanded considerably this fall (1941).

Ear Corn Storage. Field inspections of cribs in several counties throughout the corn belt have shown that cribbing corn with too much excess of moisture is hazardous, even if the crib is considered to have more than the usual amount of ventilation. In northeastern Iowa some of the corn placed in cribs in the fall of 1940 contained moisture in excess of 25 per cent. An unusual amount of corn became moldy the following spring. The corn in many cribs was disposed of or moved to prevent further damage. In almost every case the damage was due to excess of moisture. This was true even in cribs considered to be satisfactory for drying out corn of more than the usual moisture content.

Samples obtained periodically from cribs containing corn from the 1940 crop in northern Illinois showed marked differences in drying in different types of cribs. In general, the corn in single cribs not more than 8 ft wide which were well exposed, dried most rapidly. The corn in octagonal cribs, the diameters of which were from 14 to 16 ft, dried the least and contained the greatest amount of damage.

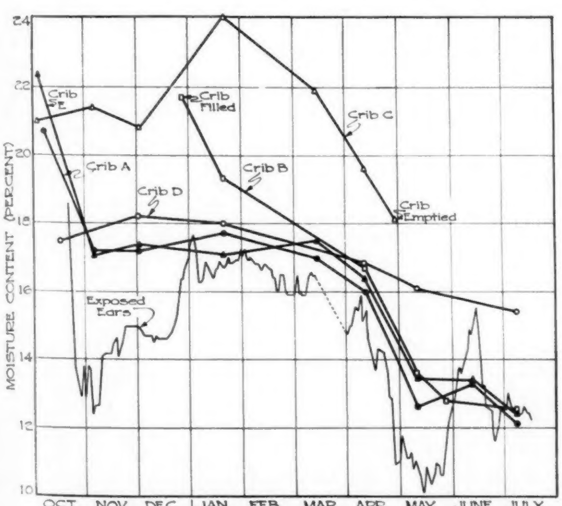


Fig. 3 Mean moisture content of corn in cribs provided with different types of ventilation through a storage season. Moisture content of kernels of fully exposed ears are also given. Symbols correspond to description of cribs in Table 2

Within the last few years a few cribs provided with the same ventilation features as those used in bins for the conditioning of high moisture wheat have been developed. These have been under observation at the agricultural engineering research farm at Iowa State College.

Observations on the performance of two types of circular steel cribs employing different methods of ventilation are worthy of comment. The one type is referred to as "wind pressure" or "downdraft" ventilation. It has a rotating cowl which faces the wind and is joined to a large central flue. The air passes into the cowl, down the flue, through the corn, and out through the wall. The other type has a suction rotating cowl and may be referred to here as "updraft" ventilation. The air is simply drawn up through the perforated floor, the corn, and the cowl by the action of the wind. Further detailed descriptions of each crib are given in Table 2.

TABLE 2. DESCRIPTIONS OF DIFFERENT TYPES OF CORNCRIBS TESTED

Reference symbol	Shape	Type of ventilation	Diam. or width, ft	Height, ft	Capacity, bu	Floor	Wall
A	Cir.	Wind pressure	14	8	500	Perf.	Wire cribbing
B	Cir.	Wind pressure	18	11	1000	Solid	Perf.
C	Cir.	Suction	14	8	500	Perf.	Solid*
D	Cir.	Suction	14	11	500	Vent.	Solid
E	Rect.	None	6½	8	500	Vent.	Perf.

*Solid with exception that lower 2 ft are perforated.

Cribs A and B are equipped with ventilators of the wind pressure type and C and D with ventilators of the updraft type. Crib E is a narrow rectangular crib which has been included here for comparison purposes.

Fig. 3 shows the observed average moisture contents of samples taken periodically from different parts of each of the different cribs through the winter and through the drying period in the spring. The daily observed moisture contents of individual ears of corn fully exposed to air is also shown for this same period. This serves as a basis for comparing the performance of the different cribs. It will be noted that the moisture contents of the corn in cribs A, B, and E are about the same towards the end of the storage period and approach the moisture contents of the exposed ears most closely. The corn in cribs C and D, having ventilation of the updraft type, dried slowly. The corn in crib C which was placed in storage with a moisture content of 20.5 per cent, actually increased in moisture content. This was due to the absorption by the kernels of moisture from the cobs, an action which has been observed to occur in parts of the crib where ventilation is poor. While some drying occurred in the spring, it was not sufficient to prevent the corn from spoiling.

On the basis of average moisture content the drying performance of the cribs provided with wind pressure ventilation was very nearly equal to that of the rectangular crib E, 6½ ft in width. These cribs were superior, however, in the drying of the corn in the center of the cribs.

The results with wind-ventilated cribs indicate that unusually good performance in the drying of high moisture ear corn can be obtained in circular cribs which are otherwise considered to be inferior to rectangular cribs. The

action of the wind on a circular structure is such as to create suction over three-fourths of the wall. By supplying air in the center of the crib under a positive pressure, greater heads or pressure differences are obtained to create air movement through the ear corn.

Shelled Corn Storage. Observations have been made periodically on dry shelled corn in storage on farms and in steel bins owned by the Commodity Credit Corporation. With the aid of funds supplied by this agency, observations now are being made on about 100 bins located in different areas of the corn belt. Samples for grade, fat acidity, and germination tests and insect counts are taken regularly. The last are made by state entomology departments and the Bureau of Entomology and Plant Quarantine. Temperatures in different parts of the bins are being observed regularly about once a month.

The observations to date have shown that the storage of dry shelled corn is generally successful, provided the corn does not have a moisture content greater than 13 per cent, is relatively free from insects, and no water leaks into the bin. After two years of storage, the top layer of corn, about a foot in thickness, appears to be in the poorest condition. The greatest increase in damage is found in this layer, largely because of an increase in moisture during the fall and winter. However, with the coming of warm weather in the spring, the layer dries out again.

During the turning and cleaning of corn in steel bins, a splendid opportunity was provided for observing the condition of corn in different parts of the bins. The junction of the bin floor and wall, which is simply a lap joint, is faulty in that it admits sufficient moisture to spoil the adjacent corn. While on the whole such spoilage has not been more than a bushel and often less, such a condition has been conducive to the development of insects. This emphasizes the importance of having bin walls and floors made tight to prevent any ingress of moisture even in the form of vapor.

Field shelled or combined corn with a moisture content of 17.5 and 21.0 per cent was stored in two wind pressure ventilated steel bins in connection with the experimental studies of bins and cribs. These were of the same type as those used with success in the storage of high moisture wheat and grain sorghums. Although the moisture content of the corn in the two bins was reduced to approximately 16 per cent by the latter part of April, corn in certain parts of the bin became musty and it was necessary to remove all the corn to prevent further deterioration. While this type of ventilation was rather successful with wheat and grain sorghums, its limitations as to the maximum moisture content at which corn can be conditioned successfully under conditions common to the corn belt remain to be determined by further trials.

Grain Sorghum Studies. Grain sorghums are becoming increasingly important feed *(Continued on page 84)*

Alternative Silo Types to Meet War Demand for Steel

By J. R. McCalmont
MEMBER A.S.A.E.

IN MOST sections of the United States more silage will be required to sustain the high level of milk and beef production demanded by wartime economy. Vital as food is, the need for machinery, guns, and other war materials requiring steel for their production is even greater. The present demand for steel for direct war purposes is likely to curtail the production of permanent tower type silos requiring steel for reinforcing. However, to meet this situation, there are other kinds of silos, such as the wooden-hoop, crib, modified Wisconsin, pit, trench, fence types, which may be used.

The tabulation in the accompanying table, showing the steel requirements of various silos (roof not included), should aid in selecting the type of silo to build when steel is limited.

So long as some steel is available, the type of silo selected will depend somewhat on other considerations, such as the money available for the investment, degree of permanence desired, locality, and the lay of the land. A good permanent silo may cost less in the end per ton of silage stored, because the cost is distributed over many years, but a temporary or less durable silo will pay dividends in increased milk or beef production by furnishing storage for the much-needed silage in this emergency period.

(EDITOR'S NOTE: Farmers' Bulletin 1820, "Silos: Types and Construction," describes commonly built types, and may be obtained free from the U. S. Department of Agriculture, Washington, D.C., so long as the supply lasts.)

Article prepared especially for AGRICULTURAL ENGINEERING. Author: Agricultural engineer, farm structures research division, Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture.

APPROXIMATE WEIGHT OF STEEL IN SILOS (EXCLUSIVE OF ROOFS)

TEMPORARY SILOS (Fence Type)

Size, ft	Capacity, tons	Length of fencing, ft	Weight of steel in fence, lb	Weight of No. 9 wire, lb[1]	Total weight, lb	Reinforcing per ton, lb
From 4-ft Snow Fencing						
16x16	45	203	69	26	95	2.1
From 4-ft, 2x4-in Mesh Fencing						
16x16	45	203	190-294	13	203-294	4.5-6.5

PERMANENT WOOD SILOS

Size, ft	Capacity, tons	Nails and anchors, lb	Reinforcing per ton, lb
Wooden Hoop			
12x40	100	100	1.0
Crib			
Six 7-ft sides, 40 ft deep	100	245	2.45
Modified Wisconsin			
12x40	100	75	.75

[1]Snow fence and light-weight mesh fence require extra reinforcing.

PERMANENT SILOS WITH STEEL HOOPS

Size, ft	Capacity, tons	No. of hoops	Weight, lb	Reinforcing per ton, lb
Corn silage[2]				
12x30	68	14	490	7.2
12x40	100	22	770	7.7
14x30	92	16	656	7.1
14x40	135	24	984	7.3
16x30	121	17	782	6.5
16x40	177	25	1150	6.5
18x30	160	18	936	5.9
18x40	224	28	1456	6.5
Grass silage				
12x30	75	19	665	8.9
12x40	116	31	1085	9.4
14x30	100	21	861	8.6
14x40	150	33	1353	9.0
16x30	116	24	1104	9.5
16x40	194	38	1748	9.0
18x30	180	25	1300	7.2
18x40	250	41	2132	8.5

[2]Calculated for normal corn silage containing from 68 to 72 per cent moisture.

The Down-Draft Metal Corncrib

By D. H. Malcom
JUNIOR MEMBER A.S.A.E.

IT IS estimated that approximately one-half the corn grown in the United States this year (1941) must be sold at harvest or stored in unsafe shelters where it will be subject to damage from weather, rodents, or rotting caused by improper ventilation. Surely it is wrong for farmers to use hybrid seed and modern equipment to produce increased yields, and then have a large part of the crop lost through improper storage facilities before it can be marketed. The solution of the problem of developing means of corn storage equivalent to those for corn production is a challenge to all engineers interested in farm buildings, as well as to building manufacturers looking for expanded markets when the war is over.

Standardized plans like those of the Midwest and other farm building plan services are a great help, but prefabrication of storage structures can play a much greater part in this market than it has in the past. It is much easier to demonstrate to a few manufacturers the basic requirements for corncribs, than it is to educate all the farmers who grow corn. Also, manufacturers are able to employ trained men to study construction problems and produce the best unit per dollar of cost. And they can utilize mass production methods to produce cribs at a minimum price to the farmer.

Economically, prefabrication is sound. It is not a case of trading farm labor at 10 cents an hour for factory labor at 60 cents an hour, for the man in the factory has the equipment to do his work many times faster than the man on the farm. However, four factors are necessary to successful prefabrication:

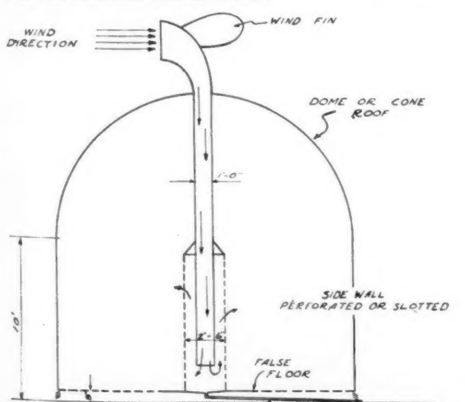
1 Adequate information on fundamental requirements of the unit to be produced
2 Properly engineered design which utilizes the material to the best advantage
3 Simplicity of design so that all labor of erection can be done by farmers with the aid of simple instruction sheets
4 A market large enough to justify extensive promotional work to create sales sufficient to utilize mass production and distribution methods. These are necessary to make costs competitive with homemade structures.

In order to utilize effectively the high tensile strength of sheet metal for corn storage, it is necessary to make the crib round. This type of construction, if kept within certain heights, can be made entirely frameless, as has been illustrated with the common grain bin. Also, it provides maximum capacity per square foot of surface area. But in the past the round crib has been confined to small diameters. The mass of corn in large diameter cribs restricted air movement, and corn in the center of the crib dried too slowly. Suction ventilators of the ordinary type with relatively small center ventilating tubes failed to overcome this difficulty.

In December 1939, C. F. Kelly (agricultural engineer, USDA) reported at a meeting of the American Society of Agricultural Engineers on his use of natural pressure ventilation in wheat bins. At both Fargo, N.D., and Ft. Hays, Kans., this system had been "found to store wheat safely with an initial moisture content of from 1 to 2 per cent higher than could safely be stored in unventilated bins." The pressure system worked with the wind pressure which is exerted on a round structure. It introduced the dry air at the center of the structure, which is the danger point, and provided positive pressure for the movement of the air through the grain. It seemed only reasonable, therefore, that if Kelly could obtain materially greater air movement through a dense crop like wheat, much better results could be had with ear corn.

It was on this theory, therefore, that the sketch shown in Fig. 1 for a down-draft crib was prepared and checked with Dr. H. J. Barre (agricultural engineer, USDA and Iowa State College) and Mr. Kelly, as well as with representatives of the metal building industry early in 1940. This design utilized sheet metal to maximum advantage. The crib could be made large enough for practical use in the corn belt, was strong enough to withstand the pressure

Paper presented December 3, 1941, at the fall meeting of the American Society of Agricultural Engineers at Chicago. Author: Agricultural engineer, American Rolling Mill Co.



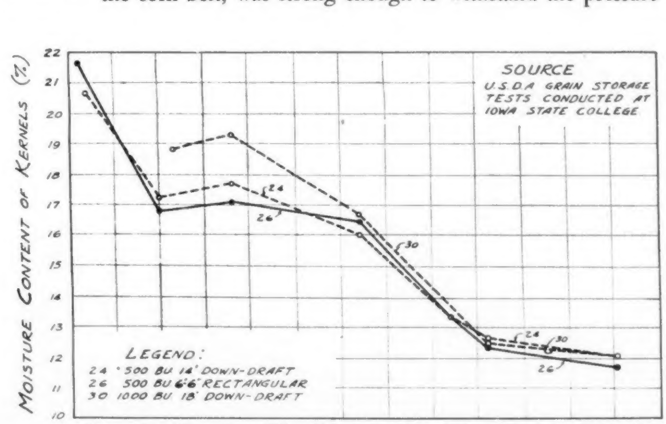


Fig. 1 (Left) Sketch of a down-draft corncrib designed to meet the fundamental requirements, established by research, for a corn storage unit • Fig. 2 (Right) A summarization of USDA tests on the natural drying of ear corn in down-draft and rectangular corncribs

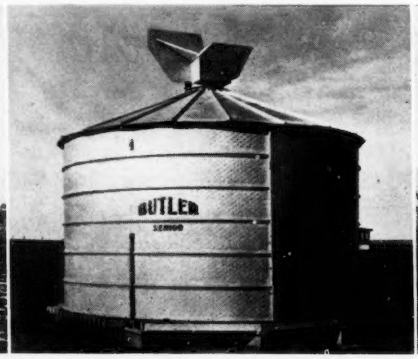
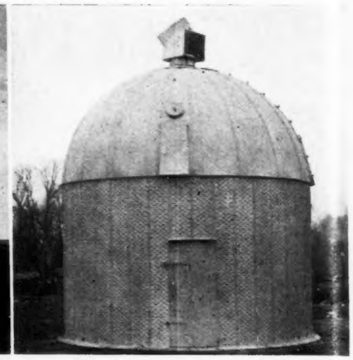




Fig. 3 (Left) and Fig. 4 (Center) Corncribs, each equipped with down-draft ventilators, used in the USDA corn storage tests on the farm operated by Iowa State College's agricultural engineering department • Fig. 5 (Right) One of the newest types of down-draft metal corncribs

of the stored corn, and theoretically it would allow sufficient air movement to dry out and keep the corn.

In the fall of 1940, after several minor changes were made in the ventilation system, Dr. Barre installed a down-draft ventilator on a crib (Fig. 3), at the agricultural engineering department farm at Iowa State College. Also he was furnished with a second crib (Fig. 4), especially equipped with down-draft ventilator. Dr. Barre has already reported on the results of these tests, which are summarized in Fig. 2. It is sufficient to say that they proved the down-draft system would supply adequate air movement in Iowa, although some work still remains to be done on distribution of the air in the crib.

During this same period, Geo. R. Shier (agricultural engineer, Ohio State University) tested two cribs which were alike, except that one crib had the rotating ventilator turned *into* the wind. Here again the down-draft crib proved superior to the crib with the suction type ventilator, although in neither case was the center flue as large as is believed necessary for best results.

Now is an ideal time for development of new products. Several manufacturers are placing limited numbers of these new cribs with farmers to obtain actual service tests. One of the newest of these is the crib shown in Fig. 5. These units will be watched carefully and the results will aid in improving the crib and reducing the cost, for there is much to learn as to just how economically we can build this type of unit and still get safe storage.

Right now it seems that in the 1,000-bu units we can use a solid floor and the size of the center ventilating tube can be less than those tested by Dr. Barre. However, on the larger cribs a ventilated floor will probably be necessary because of the accumulation of shelled corn and foreign matter at the bottom of the crib. Also, in certain sections where wind velocity is low and corn moisture content high, the diameter of the center ventilating tube may have to be increased in proportion to the diameter of the crib.

However, the fundamental design of the cribs presents very definite possibilities: (1) The crib can be made to meet the requirements of corn storage over most of the corn belt; it is durable and has ample structural strength; also, it is ratproof, fire and lightning proof, and easily sealed. (2) It is designed to use a minimum amount of metal for the storage space created; a crib holding approximately 1100 bu of ear corn can be made from slightly more than a ton of sheet metal. (3) It can be erected by any farmer and his hired man with the aid of a very simple instruction sheet. (4) It is a market large enough to repay the efforts of the pioneers who are carrying on the development program.

The down-draft corncrib is not the only answer for corn storage, but it looks like a good one. Also, it is proof that when essential requirements of a unit are known, there are ways of meeting them with various materials, and there are manufacturers willing to carry on the development work necessary to perfect the structure and stimulate the market. The development of the down-draft crib is an excellent example of practical cooperation between the federal department of agriculture, state colleges, basic material producers, building manufacturers, and farmers.

Some Engineering Phases of Grain Storage

(Continued from page 82)

crops, particularly in Kansas, Texas, and Oklahoma. Since the crops mature rather late in the fall, they usually contain considerable excess moisture, unless the weather conditions have been favorable for drying throughout the greater part of the fall. The drying of grain sorghums in ventilated bins is difficult because the weather conditions in late fall and winter are poor, due to lower temperatures and higher humidities.

In 1939 a study of grain sorghum storage, supported by Bankhead-Jones funds, was begun at Hays, Kansas. This project was conducted cooperatively by the U. S. Department of Agriculture and the Kansas Agricultural Experiment Station. Several different types of both natural and power ventilation systems were observed. A partial report of the results has been given in AGRICULTURAL ENGINEERING by F. C. Fenton (May 1941).

The study is to continue on the same basis as in the past, with the exception that experimental storages are to be set up at Hutchinson, Kansas, where the experimental bins which have been used for conditioning high moisture wheat, can be made available for use in conditioning grain sorghums containing excess moisture.

RECENT PUBLISHED REPORTS ON GRAIN STORAGE INVESTIGATIONS — Conducted by the Bureau of Agricultural Chemistry and Engineering (USDA) in cooperation with other federal and state agencies.

Methods of drying grain on the farm, by C. F. Kelly. Agr. Engr., April 1939.

Results of research in corn storage, by H. J. Barre. Agr. Engr., June 1940.

Research work in wheat storage, by C. F. Kelly. Agr. Engr., December 1940.

Drying artificially heated wheat with unheated air, by C. F. Kelly. Agr. Engr., September 1941.

Methods of ventilating wheat in farm storages, by C. F. Kelly. USDA Cir. 544, April 1940.

Temperatures of wheat in experimental farm-type storages, by C. F. Kelly. USDA Cir. 587, February 1941.

Grain storage on the farm, by T. E. Long and M. G. Cropsey. N. D. Agr. Expt. Sta. Bul. 302, June 1941.

Engineering problems in grain storage, by G. J. Burkhardt. Agr. Engr., December 1940.

Storage of grain sorghums, by F. C. Fenton. Agr. Engr., May 1941.

Wheat storage in experimental farm-type bins, by C. F. Kelly, B. M. Stahl, S. C. Salmon, and R. H. Black. USDA Cir. 637 (in press)

The Wood Hoop Grain Elevator

By Roland A. Glaze

MEMBER A.S.A.E.

THE TYPE of grain bin discussed in this paper while unusual in design, if not in principle, seems to meet the set of circumstances which prompted its origin. The problem of additional storage space faced the operators of a line of elevators in the Dakota wheat country and consideration was given to a dozen different methods of enlarging their elevators which would soon be bulging with grain. Several experimental bins were built and tested. Early last spring this organization appealed to us to help solve their problem, and there was developed a more economical grain bin construction system utilizing materials readily available in any lumber yard.

The problem as presented by the elevator company was (1) to provide as much storage as possible for as low a cost as possible; (2) to be of such a size and shape as to occupy the right of way between the trackage and the road, usually 30 ft, and to utilize if possible the existing elevating and spouting system, and (3) to be salvageable to as high a degree as practical.

Fig. 1 shows bins of two sizes after erection. Note that they look not unlike water tanks or silos. Actually they are silos with wood hoops. The wood hoop silo has long been known for its stability, economy, and ease of erection, and it was relatively simple to adapt this principle of construction to the storage of grain.

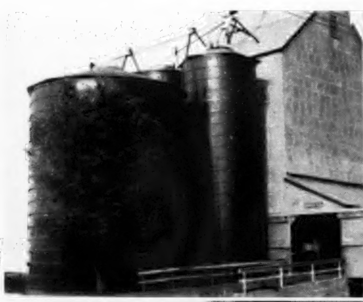
The wood hoop makes it possible to use ordinary $1\frac{1}{4}$-in Douglas fir flooring for lining instead of the thick staves required when steel hoops are used. Since each piece of flooring is fastened to each hoop intersection with two nails a rigid wall is the result. The large bin shown is 28 ft in diameter by 40 ft high, and the smaller one is 16 ft in diameter by 48 ft high.

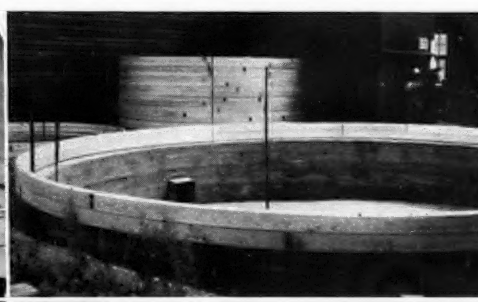
Commercially fabricated laminated wood hoops proved to be ideal for the grain bins described in this paper, but since most of the bins are 28 ft in diameter the problem of shipping and need for immediate delivery brought the engineers to the conclusion that building the hoops on the site was the only way to meet the situation. The first hoop built took seven men all day, but a system was worked out so that the rest were built in three man-hours per hoop or less.

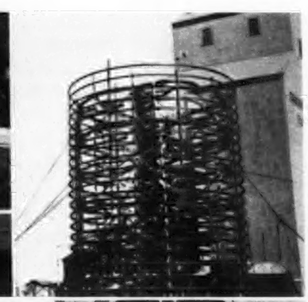
The roof plates are set up on horses and are used as a form. Strips of resawn pine are bent against blocks nailed on the plate after being coated with casein glue. Sufficient nails are used to hold the laminations together while the glue is setting. A piece of bevel siding was used as a base for the hoop laminations so that the top edge of the hoop would slope to assist in shedding rain. After the hoop is removed from the form, the top edge is further smoothed with a hand plane. While one crew of men is building the hoops, another crew is building the concrete foundation.

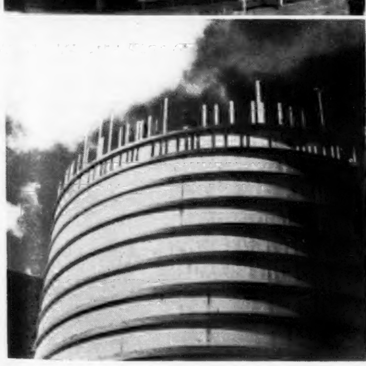
Hoops are next placed on the foundation ready for the erection crew (Fig. 2). The foundation and hoop crews move on to the next location. The erection crew of six men completely erect a large bin in one day. Most of the time is taken up with building a *(Continued on page 87)*

Paper presented December 3, 1941, at the fall meeting of the American Society of Agricultural Engineers. Author: Chief engineer, Weyerhaeuser Sales Co.









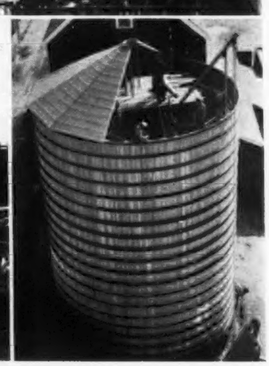


Fig. 1 (Upper left) A 28-ft and a 16-ft grain bin after erection. These bins are of glued laminated wood hoop construction • Fig. 2 (Upper center) Wood hoops placed on the foundation ready for the erection crew • Fig. 3 (Upper right) All the hoops in place ready for the lining • Fig. 4 (Lower left) The lining of Douglas fir flooring nearly completed • Fig. 5 (Lower center) Roof sections being constructed on the ground • Fig. 6 (Lower right) Putting the roof sections in place is the final stage of construction of this type of bin

Wartime Shortages Challenge Chemist and Engineer

By W. B. Van Arsdel

WITHIN a day or two after the Japanese, German, and Italian nations declared war on the United States, Secretary of Agriculture Wickard said, ". . . . . the job . . . . is to help American farmers turn out exactly what our nation and our allies need in the way of farm products, at the time they are needed; and to help in seeing that most effective use is made of these products . . . The part of the government workers in agricultural agencies is to help farmers and transporters and distributors keep production rolling . . . . We will have to help farmers perform this job in the face of shortages of supplies and materials," and he might well have added, ". . . and shortages of equipment, of transportation, and of man power."

Surely here is a challenge to everyone in any way connected with agriculture; we must overcome those difficulties and do the job that has to be done. Shortages must not, and will not, stop us.

The most immediate concern, naturally, has been to assure the required pattern of production. Farmers are being asked to bring about substantial increases in the production of certain vital commodities. Those goals will certainly be attained, in spite of whatever scarcity of farm equipment, bags, twine and wire, fertilizer, insecticides and fungicides, and man power the farmer may encounter; for the farmer is a man of resourcefulness and ingenuity. I suspect that many a farm tool will be improvised, and many more will be kept in repair, with the help of the crossroads garage and service station or right on the farm itself.

While I do not mean to minimize the difficulties that will face the farmer as producer, I do wish to speak primarily of the dangers, the difficulties — yes, the opportunities — of wartime processing and distribution of farm products. The whole job is a failure if the farmer's bountiful production cannot be moved to the people who need it. That is the other half of the job — and in some ways the more difficult, the more uncertain half.

There is a significant change in emphasis from the days of 1917. Then the spotlight was on wheat; now it is on meats, dairy products, eggs, fruits, and vegetables. In contrast to wheat, all of these things are highly perishable. That is one of the reasons why questions of processing and transportation have become so critical. The problem comprises the whole technology and organization which has grown up around the audacious idea of defeating perishability. For one thing, at the same moment that the magnitude of the task was visibly expanding, accustomed means of expansion were being denied to us, one after the other. The most unimaginative can see what shortages of sheet steel and tin portend. It is equally easy to see how vital it is to make the best possible use of every cubic foot of cargo space on ocean-going vessels. Not so immediately obvious, perhaps, is the necessity for conservation of domestic transport, both by rail and by truck, whether through elimination of wasteful cross-hauling, through full loading and quick turn around, through reduction of spoilage en route, or through semiprocessing and reduction of weight and bulk close to the point of origin.

Paper presented January 9, 1942, at a meeting of the Pacific Coast Section of the American Society of Agricultural Engineers at Davis, Calif. Author: Chief, engineering and development division, Western Regional Research Laboratory, Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture.

The group with which I am connected is deeply engaged in attack on some of these problems. One of the promising avenues of approach is food dehydration, since both weight and bulk may be very greatly reduced. The major emphasis of the work is being placed at present on the dehydration of vegetables and eggs.

Dehydration of foods is one of the three major traditional ways of defeating perishability, the other two of course being sterilization by heat and holding under tight seal — that is, canning — and storage at low temperature, especially below freezing. The drying of foods to make them keep is a very old art, and one which has been brought to a high degree of perfection in the case of such farm products as fruits. On the other hand, the development of satisfactory methods for dehydrating vegetables has lagged. The coming of the emergency found this country possessed of only a few relatively small plants in which vegetable dehydration was being carried on commercially. Surveys indicated that the total amount dried during the year 1940 was less than 1 per cent of the amount commercially canned or frozen, and by far the largest part of this production was for use in dehydrated soup mixtures. A certain amount of technical information was available, most of it dating from the shipping crisis of the last war. The flurry of activity in dehydration at that time died down shortly after the close of the war, apparently because the products had little consumer appeal. It remains to be seen whether further development of the art will so far improve dehydrated vegetables that they will achieve an important place in the postwar economy of farm products. Preliminary results of the research which is now being carried on at the Western Regional Research Laboratory indicate that this is a real possibility.

The problems of rapid emergency expansion of the industry are quite different, however, from those which would have to be solved in the course of normal peacetime growth. In particular, wartime shortages of the commonest engineering materials make new plant construction a complex puzzle for the engineer. He finds the supply of steel, of galvanized sheets, of monel metal or stainless sheets, of pipe, valves, and fittings, of blowers, of motors, and of all kinds of preparation and handling machinery is short and almost sure to become shorter; some important items are obtainable only on defense priorities. Ingenuity in the use of alternatives and expedients becomes all-important. For example, it may be essential to devise means for transporting many of the scarcer items of equipment from one dehydrator to another, in order to take advantage of differences in harvest season and to increase the load factor of the equipment. Refinements which would serve only to make minor savings in operating cost may be put aside. The attainment of maximum production of a satisfactory product within the shortest possible time becomes the single objective.

I have spoken of this particular project not alone because it illustrates so well the peculiar urgencies and difficulties of wartime development, but also because it illustrates the kind of permanent constructive achievement which may grow out of an emergency effort. If the pressure of necessity drives us to the discovery and application of substantial improvements in the technique of dehydration, agriculture should be a permanent gainer, for we shall

have established a third means of defeating perishability, which can take its place in our economy alongside of canning and freezing.

Consideration of the points at which wartime shortages are already beginning to hurt makes me believe there are numerous other great opportunities for American agriculture — opportunities which we might overlook were it not for the peremptory challenge of war. The difficulties — and the opportunities —cover an extraordinarily wide area of our normal American way of life. The old Army-Navy list of strategic and critical materials has expanded within a few months to embrace more than three hundred commodities. Some of them are household words — rubber, tin, aluminum, steel. Others are so unfamiliar that only a specialist would recognize them, and yet they too are essential cogs in our complex American machine.

WARTIME SHORTAGES PROMISE TO BROADEN THE UTILIZATION OF AMERICAN AGRICULTURAL PRODUCTS

American agriculture has a double interest in this problem — an interest as a great consumer of the missing commodities, and an interest as a potential supplier of alternatives, or replacements. Of course, there is a whole group of material shortages, principally among the metals, which simply cannot be overcome by utilizing farm products; organic chemistry holds out no hope of synthesizing good electrical conductors like copper. But there are many other scarce materials for which replacements are perfectly possible, and on these possibilities research and development are being pushed with the utmost speed. While some of this work has military significance, so that discussion would be inadvisable, it is no secret that research is being pursued on the development of rubberlike materials from farm products; on modification of American animal and vegetable oils to produce new drying and soap oils; on the use of cotton for some purposes formerly reserved for imported fibers; on the production of plastic structural materials from low-cost farm wastes and residues; on the development of domestic root-starches; on the extraction of vitamin concentrates from domestic commodities; on the production of tanning materials from American sources; on the recovery of alcohol and numerous other essential organic chemicals and solvents from common farm products; and on numerous other fronts of present or prospective shortage.

These are all opportunities for American agriculture, particularly if the developments are so sound that they continue on the force of their own merit into the postwar economy. Agriculture, like any other industry, gains when the field of utilization of its products is broadened and diversified.

The agricultural engineer will be key man in the effort to reach many of these objectives. Further reductions in the man power required per unit of production will be essential in many cases. Revolutionary changes in methods of planting, tilling, harvesting, and handling some crops may be required. The necessity for economy of transportation and of investment in processing plants will put a high premium on the development of primary processing steps and storage facilities close to the farm. Failure to reach acceptable solutions to these problems will not only hold back the war effort, but will also seriously jeopardize the conversion of war emergency measures into permanent postwar industries.

As Secretary Wickard said, everyone of us must help to keep production rolling. It is our good fortune that success in meeting this challenge may also contribute largely to the richness and security of the peacetime world.

The Wood Hoop Grain Elevator

(Continued from page 85)

scaffolding inside the tank. As soon as the scaffolding is ready, all except the bottom four hoops are raised. Then these bottom four hoops are spaced using 2x4-in blocks cut to length. The hoops are next raised higher, with the exception of four more, and so on until all of the hoops are in their proper location.

Fig. 3 shows all the hoops in place ready for the Douglas fir flooring which makes up the lining, and Fig. 4 shows the lining nearly completed. Hoops were originally designed to be spaced 24 in on centers, and the number of plies in the hoops were decreased with the reduction of the grain pressures towards the top of the bin. One bin was built with smaller hoops with the spacing varied, but standard lengths of flooring made it seem advisable to adopt the uniform spacing system as standard.

Roof sections were constructed on the ground (Fig. 5) by three men, while the rest of the six-man crew was erecting the scaffolding work. Fig. 6 shows placing of roof sections.

To date this elevator company has built 62 wooden bins with a total capacity of over a million bushels. As mentioned before, many other systems of construction were tried, including steel tanks, cribbed wooden bins, and concrete stave bins. A recent interview with their chief engineer revealed the fact that the wood hoop bins can be erected in 5 days each, approximately a week less than any of the other types, and that the cost is from 15 to 20 per cent less than the lowest of the other types. The cost of bins 28 ft in diameter by 48 ft high, with a capacity of approximately 24,000 bu, was 9c a bushel. The smaller bins cost 12c a bushel. A large share of this cost was taken up by a rather elaborate concrete foundation.

This type of bin was first thought of as an emergency measure, and more or less a temporary proposition. After building several of them, however, the operators expressed themselves as seriously considering adopting this type of construction to replace even their permanent elevators as replacement becomes necessary. Requests for plans from all of the major wheat-producing areas of this country, as well as from Canada, South America, and Mexico, have been received since the first few bins proved their practicability.

Various systems of wind bracing have been applied and all will be carefully watched. Naturally because the walls of these bins are relatively thin, all filling and emptying must be done from the center.

For economical grain storage which can be built of readily available, non-critical materials in an extremely short time, the glued laminated wood hoop method of construction should have serious consideration.

Engineering in Chemurgy

AGRICULTURAL engineers are making their contribution to farm chemurgy in connection with their work of lowering the cost of production of, and thereby widening the market for, the standard farm crops which represent large volume production. Cotton, grains, and soybeans in particular have shown great promise of expanding industrial use, subject to realization of lower production costs. In the case of cotton, production and harvesting methods are already a factor in the grades of fiber produced. It seems likely that, as industrial use of other farm crops increases, there may be demand for production methods and equipment to help meet new and specialized industrial grade and delivery requirements.

Freezing and Storing Food on the Farm

By P. T. Montfort

MEMBER A.S.A.E.

INTEREST in low temperature refrigeration on farms has been growing rapidly. In fact, recent developments have brought into use equipment and methods perhaps dreamed of but hardly expected by the pioneers of farm refrigeration some fifteen years ago.

Some of the factors contributing to this increased interest are (1) the development of the technique of freezing and storing foods at low temperatures, (2) improvements in refrigeration equipment, (3) the widespread availability of electric service, (4) a better knowledge of diets, and (5) changes in farming practices.

The technique of freezing and storing foods at low temperatures developed and popularized by the commercial frozen foods industry and locker storage plants has opened up tremendous new possibilities for the preservation of the farm food supply.

There has been a remarkable development in the field of small electrically operated refrigeration equipment during the past ten years. The list prices of small compressors have been reduced 35 to 40 per cent since 1931. The Btu per hour output has been increased approximately 125 per cent. The expected life of the equipment has been increased 25 to 35 per cent, and electric rates have been lowered about 37 per cent. Considering all these factors, the cost of a ton of refrigeration from a 1/2-hp compressor will cost today less than one-third as much as it would have under similar operating conditions in 1931.

The extension of electric lines into rural areas during the past two decades has made low cost electricity available to more than 2,000,000 farms. This expansion is going ahead at the present time at the rate of some 200,000 farms annually. Electricity makes possible the economical operation of small automatic refrigeration equipment.

Many of us have been somewhat smug in the belief that we were the best fed nation on earth. We are finding, however, upon close scrutiny, and in the light of present knowledge of the effect of diets on our well-being, that perhaps after all there are some deficiencies. A recent report by the U. S. Bureau of Home Economics (Misc. Publn. 430) indicates that only 27 per cent of all families in the United States have a diet which might be defined as "good". This report also showed that only 50 per cent of the farm families in the United States have a "good" diet.

Paper presented June 25, 1941, at the annual meeting of the American Society of Agricultural Engineers at Knoxville, Tenn. Author: Research associate in agricultural engineering, A. & M. College of Texas.

Farming practices, particularly in the South, have been undergoing radical changes. Between 12 and 15 million acres of land have been taken out of cotton production, much of which is now being used to produce meats, eggs, poultry, milk, cream, butter, fruits, and vegetables. Good refrigeration equipment is essential if these foods are to be properly preserved for use on the farm or marketed most efficiently.

Facilities for freezing meats, fruits, vegetables, and other suitable foods at low temperatures (0 F to –40 F) and storing at temperatures from 0 F to –10 F are made available to farm people either at centrally located locker storage plants or with refrigeration units designed for individual farm use, or by a combination of the two. The more common practices in using these facilities are as follows:

1 Central locker plant for processing, freezing, and storage, with no refrigeration equipment on the farm.

2 Central locker plant for processing, freezing, and storing, and using the standard household refrigerator with oversize freezer compartment (2 to 10 lb capacity) for storing a few days supply at the farm.

3 Central locker plant for processing, freezing, and storage, and the household refrigerator with large (1 to 6 cu ft) freezer compartment holding one to two weeks' supply of frozen foods on the farm. The large freezer compartment in this type of refrigerator is suitable for freezing small quantities of products on the farm.

4 Individual farm freezer chest (2 to 30 cu ft) for freezing and storage on the farm, with perhaps some chilling and freezing done at central locker plant in summer months.

5 The all-purpose farm refrigerator which has complete facilities for chilling, freezing, and storage at the farm.

Each of these practices embodies certain definite advantages and disadvantages when used under specific conditions.

The central cold storage locker plants are rendering a real service to farm people, and the use of such a plant in connection with a household refrigerator having a freezer compartment of 1/2 to 1 cu ft capacity probably affords the most economical frozen storage facilities to meet present demands of a very large percentage of farms. No large investment is required. Complete services including slaughtering, chilling, aging, cutting, packaging,

and freezing are available. The processing is done by an experienced operator. This will probably result in higher quality products. Also there is less possibility of losses during equipment breakdowns.

There also appears to be a definite place for home freezing equipment, either as individual freezer chests or as freezer compartments in above-freezing "reach-in" or "walk-in" farm refrigerators. The most promising field for the use of this type of equipment at the present time is on large farms, ranches, and country estates, as well as those farms located a considerable distance from a central locker plant.

A number of manufacturers, agricultural colleges, and other agencies have been giving considerable attention to the development of freezer storage equipment best suited to farm needs. Progress has not only been rapid, but it has been well recorded in the literature of both private industry and public service agencies. There is need, however, for additional research which will lead to wider acceptance of freezer storage equipment on the farm. Such research should take up problems in design, construction, distribution and application. The primary objectives should be to lower first costs, to reduce operating costs, and to develop greater possibilities for using the equipment to increase farm income.

Some of the more important problems which have been suggested as needing further study are presented in the following paragraphs:

1 *Value to the Farmer.* There is very little definite information available today by which the value of frozen storage facilities to the farmer may be measured. It has been variously estimated that frozen storage for preserving the farm food supply for a family of five is worth from $50.00 to $100.00 per year. These figures are not based on actual farm experience.

THERE IS NEED FOR DEFINITE INFORMATION TO MEASURE THE VALUE OF FROZEN STORAGE

The out-of-pocket cost of frozen storage with different types of equipment can be fairly accurately estimated on the basis of present information when applied to a specific case. If a farm family living in a locality where the mean annual temperature is 70 F uses a 30-cu ft freezer chest (with 8 in of insulation and costing $300.00) to store 1200 lb of food per year the cost will be approximately as follows:

Depreciation (12-year basis)	$25.00	per year
Interest (at 6 per cent)	9.00	" "
Repairs to equipment	6.00	" "
Wrapping and packaging supplies	12.00	" "
Operation (electricity at 3c per kw-hr)	38.62	" "
Total annual cost	$90.62	
Cost per month	7.55	

What is the value of the labor involved in slaughtering, cutting and wrapping meats, and preparing and packaging fruits and vegetables? What cash value may be placed on the convenience of always having an ample supply of a good variety of frozen foods on hand?

If the same amount of food is stored at the locker plant, the cash outlay will be approximately as follows:

Locker Rental —	
3 6-cu ft boxes at $10.00 each per year	$30.00
1 6-cu ft box — 9 mo at $1.00 per mo	9.00
1 6-cu ft box — 3 mo at $1.00 per mo	3.00
Processing, packaging, and freezing —	
500 lb meat at 1½c per lb	7.50
700 lb of fruits and vegetables at 3c per lb	21.00
Total annual cost	$70.50
Cost per month	5.88

This does not include any charge for extra trips to town. Many farmers make one or two regular trips to town each week and a large portion of the food supply stored at the locker can be secured at the time of these trips. It is probable, however, that a farmer using as much as 1200 lb of frozen food per year will be required to make a few extra trips to the locker plant.

How many of these extra trips will be required under average farm conditions? How much will they add to the cost of using locker services? At the present time, frozen storage facilities are used primarily for the preservation of the home food supply. What are the possibilities for using these facilities to increase farm income through the sale of frozen products such as dressed poultry, vegetables, fruits, and berries?

2 *Size of Equipment Needed.* How much freezing and storage space will be needed for the preservation of the farm food supply? How much food will the farm family freeze, at what season of the year will it be put in the locker, and when will it be removed?

THE QUESTION OF HOW MUCH FREEZING AND STORAGE SPACE HAS NOT BEEN ANSWERED

These questions will be difficult to answer because of the possible changes in farm practices which may result from a better recognition of the value of preserving foods by freezing. The problem is further complicated by the changes in farm food habits which may result from the present national program emphasizing the need for better diets.

We do have a number of reliable estimates which will be of assistance in establishing space requirements. More definite information can be secured only through careful and extensive investigations.

The Texas State Nutrition Committee, a subcommittee of a national organization, recently adopted a standard which sets up the amounts of the various kinds of food needed to supply the necessary proteins, minerals, and vitamins in the proper proportion for good health and vitality. This standard indicates an average annual food supply of approximately 2000 lb per person. Eight hundred pounds of this amount consists of meats, fruits, and vegetables which could be frozen satisfactorily. A considerable amount of these products will be consumed fresh or processed by some other method than freezing. This is desirable because it will lend variety and interest to the diet. At the present time the average amount of food frozen and stored in locker plants in the United States is approximately 700 lb per family.

Miller and Dana[1] recommend freezer chests or compartments of not less than 50 cu ft and suggest that many farmers will prefer freezers of 60 to 75 cu ft.

The farmer who is using equipment for freezing foods to be marketed, will constitute a special problem and the size of freezer will depend upon the quantity of products and the length of storage period.

3 *Insulation.* Insulation is perhaps the most important single feature of a farm freezer chest. The amount and type of insulation used has an important bearing on the first cost of the box, the size of compressor needed, and the cost of operation. Insulation is of particular importance throughout the South where long periods of high natural temperatures place an unusually heavy burden on refrigeration equipment. The optimum thickness of insulation will be determined by heat conductivity of the insulator, the cost in relation to efficiency, mean annual temperature,

[1]Building the Farm Freezing Plant, Extension Bulletin 257, State College of Washington.

maximum temperatures, temperature differentials, and cost of electricity.

Calculations based on generally accepted heat leakage factors indicate that under temperature conditions similar to those at College Station, Texas, the extra investment incurred in increasing the insulation of a homebuilt zero box (insulated with low-cost "fill" material) from 6 to 10 in will be entirely offset by savings in operating cost in a period of about 1.4 yr. The extra cost of 14 in of insulation as compared to 10 in would be repaid in about 4.2 yr. The savings incurred by increasing the insulation from 14 to 18 in would take about 52 years to offset the extra cost.

Since first cost is such an important factor in the acceptance of freezing equipment by the farmer, the final selection of the most practical thickness of insulation will probably be a compromise. Even though a thickness of 14 in of insulation would be justified on the basis of overall cost, it might be more practical to use 8 to 10 in in order to keep the first cost down and to simplify construction and distribution.

There seems to be a real need for additional accurate information in regard to the actual heat losses through the walls of small freezer chests under different conditions of temperature differential and insulation thickness. It appears that heat leakage factors generally accepted for various insulation and wall thicknesses may not apply to refrigerators of the relatively small inside dimensions of the present farm freezer chests. On the basis of present accepted factors the heat leakage into a 30-cu ft box with a 70 F temperature differential appears to increase as the thickness of insulation exceeds 18 in of cork equivalent.

AN IMPORTANT FACTOR FREQUENTLY OVERLOOKED IN DESIGNING FARM FREEZER CHESTS

Another factor frequently overlooked in the design for farm freezer chests is the relation of heat leakage to total refrigeration requirements. The heat leakage into a 30-cu ft freezer chest with 8 in of insulation, operated at 0 F with mean annual temperature differential of 70 F, is approximately 96 per cent of the total annual refrigeration load when 1200 lb of products are frozen during the year. A ten-can milk cooler has approximately the same inside dimension as the 30-cu ft freezer chest. If a ten-can cooler with 8 in of cork, operated at 32 F with a mean annual temperature differential of 38 F, is used to cool 20 cans of milk per day the heat leakage will be only about 7 per cent of the total annual refrigeration load. The addition of 4 in of insulation to the walls of the freezer chest will reduce operating cost approximately 8 per cent, while the same amount of insulation added to the walls of the milk cooler will reduce total operating cost only 1 per cent. The total difference in operating cost will, of course, be the same in both cases.

Cork has long been accepted as a standard of quality in insulating materials. The price of cork has restricted its use in farm refrigerators for a number of years. It has now been placed on the priorities list and is practically unattainable for this use.

There are a number of other good insulating materials available. These include the "sealed" or vaporproof types which are relatively inexpensive and easy to install. The less expensive "fill" and "bat" types will give excellent results if properly installed. One of the major problems in the use of fill or bat type insulators is to make the outside wall vaporproof. This is extremely difficult when frame construction is used. The plywoods, composition boards, and sheet metal offer interesting possibilities for simplified construction and more effective vaporproofing.

4 *Refrigeration Equipment.* One field of investigation in the application of refrigeration equipment to farm freezer chests which seems to offer definite promise is that of using eutectic solutions for storing refrigeration. This practice may permit the use of smaller compressors and eliminate much of the hazard of food losses during occasional power interruptions. Forty gallons of a eutectic solution of sodium chloride in holdover plates or in the walls of a 30-cu ft freezer chest with 10 in of cork equivalent insulation will store sufficient refrigeration to maintain a temperature of –5 F to 0 F in the freezer chest for a period of approximately 2½ days, with an outside temperature of 100 F and with the power off.

Without holdover facilities a compressor of 2720 Btu per hr output is required to take care of the daily heat leak and to cool and freeze 250 lb of products from 90 F to 0 F in 20 hr operation with the outside temperature at 100 F. With 40 gal of eutectic solution in the walls of the chest, the 250 lb of products could be chilled and frozen and heat losses cared for when using a compressor of 1133 Btu per hr output. The compressor operating continuously would overcome heat losses and refreeze all of the solution within about 90 hr.

INFORMATION NEEDED ON THE EFFECT OF RATE OF FREEZING ON THE QUALITY OF PRODUCT

The most common substances forming solutions having eutectic points of approximately 0 F are salts such as sodium chloride, ammonium nitrate, ammonium chloride, and sodium nitrate. Unfortunately solutions of these substances are highly corrosive. Control of this corrosion is an important problem involved in the successful use of these solutions in farm refrigerators.

There is a definite need for more specific information regarding the effect of the rate of freezing upon the quality of product. This will indicate the need for increased air circulation or other means of speeding up the freezing process which may in turn have a considerable effect on the cost of building the freezing equipment.

What are the possibilities for lowering manufacturing and distribution costs through standardization to provide a relatively small number of models designed to meet the needs of from 80 to 90 per cent of the farms?

5 *Methods of Operation.* There is need for further investigation along lines other than those involved in the design and construction of the mechanical equipment. More information is needed in regard to suitable varieties of vegetables and fruits adapted to various localities.

More information is needed with reference to the most satisfactory containers and methods of preparation.

Recommendations for carefully planned schedules of food production based upon local climatic and soil conditions and farm practices are needed to enable the farmer to use frozen storage facilities to the best advantage.

Those of us who are closely associated with and vitally interested in the farm refrigeration program can derive considerable satisfaction from the fact that a number of manufacturers are now making and selling farm freezing equipment; from the fact that many agricultural colleges are conducting extensive research programs and have prepared plans for use by the farmer who wishes to build his own equipment; and, above all, from the fact that many farmers are now using the equipment with satisfactory results.

Training for the First Job

By A. W. Turner

FELLOW A.S.A.E.

TRAINING for the first job, otherwise known as job training, could lead to unlimited discussion if applied to present wartime skills and professions. However, this paper will be restricted to the farm equipment industry. To further simplify, the presentation will be divided into three parts: (1) The need for training by industry, (2) the several types of training provided, and (3) organization and training procedure.

Two things are vitally important to successful training whether it be in college, on the job, or self-acquired, namely, (1) the desire to get a hold on the ladder of self-support, and (2) the ability to climb the ladder on accumulated experience and training.

It seems to me it is equally as important—maybe more so—that the individual be instructed on how to get a hold on the first rung of the ladder, and then taught how to climb so that he will not have his hands stepped on by others ahead of him.

Most professions and industries have employed training programs to assist new employees to get a firm hold on the ladder, possibly for two purposes: (1) to reduce the turnover and (2) to lower the starting cost. Numerous industrial firms developed plant training programs to provide foremen and junior executives for production activities. At first this training was based on converting graduate engineers from college generalities to the companies' specific requirements. Training was also experimented with through undergraduate summer employment.

Industry experimented with another job, namely, to speed up apprentice training. The old method, where the master of the craft guild trained a student to take his place, was effective under former conditions but not for the tempo of the automotive age.

Again industry began to expand the weekly sales conferences into extension programs to upgrade not only its own salesmen, but also the dealer organizations representing them. Later came specific training in sales and service at either the factory or the home offices.

I am giving this background merely to show you that experimental ground work, was well under way for an industry-wide "first job" training program when our nation went all out for defense in 1940. Then with the governmental urge and a nation-wide consciousness that we were living in a mechanical age—military as well as industrially and agriculturally—job training became a household term over night. And job training is now a prerequisite to industrial employment. Industry is also taking over important phases of instruction in the trades and skills of the armed forces.

Let me return now to the need for "first job" training for college-trained engineers. Some groups go on the theory that colleges should train for the last job provided the students are taught that the last job will, in most cases, be several years distant and require a great deal of practical experience. In training for the last job, this group urges that the schools give good stiff training that will weed out every man who cannot "take it".

Coming to the second part of this paper, let's see what types of training are required for the first job. I will divide this according to the previous training of the individual (1) college graduates, (2) high school graduates, and (3) high school students.

1 *College Graduate.* It is to the advantage of any person with executive qualifications to know the working skills required, the working procedures, and the working conditions of all persons who will be under his jurisdiction. The only way he can gain that experience is to do the jobs. So industry has found it advantageous to itself and the employes to induct the men through several first-job periods. I assume you are more or less familiar with this training, so I will not discuss it further here.

2 *High School Graduate.* That includes all who do not finish college. This group requires more intensive training for its first job, because in the majority of cases they will not obtain the ultimate goals of the previous group. However, any ambitious member of the high school group has the opportunity to compete with any others, and there are many shining examples of their success along this line in all trades and vocations.

Take the company I represent and its training of high school graduates. There are several openings for them and each has its particular training needs. The two largest groups are factory workers and merchandisers — sales and service. We have regular training courses for apprentices at the plants covering two and four years' time. Likewise, we have had training courses for mechanics or servicemen. However, new problems arose this past year. Take the motor truck division as an example. Our program of training motor mechanics at our several stations was expanding normally. But the defense program changed that picture. First, more freight was being moved by truck, resulting in more than the normal annual increase in service; second, the rapidly expanding defense industries offered very keen competition for any person with mechanical knowledge; and third, the armed forces took many men.

Fortunately we sensed this in part and streamlined our programs on short notice. We increased the number of trainees at scores of service stations. We improved our programs and upgraded our instructors. The training was intensified and length of course shortened.

Then national defense was the watchword—now it is *war effort,* so that competition for mechanics from the rapidly expanding industries and military service becomes more acute every day. And on top of that fewer new trucks and increased traffic increase service demands. For the emergency it was necessary to change our plans and change them quickly. Men are classified according to their accomplishments and we look for more mature men to take training.

The rapid growth of power farming has demanded an expansion of training programs for dealers and dealer organization. We first experimented with a group of selected stores which in turn has grown to more than a thousand across the entire country. The course offered these men is an interesting and practical course. The instructional material, including outlines and illustrations, supplements the almost unlimited amount of actual parts, new and used, that are available. Instructional material is prepared in units. A unit applies to one particular type of machine and includes setting up, adjustment in the field, and servicing. All the machines in each community are covered

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as well as tractors in this course. The men who complete this course should be A1 mechanics and able to assume responsibility in any service station.

Early in 1941 the farm equipment industry realized there would be an increased demand for food with a possible reduction in food producing machinery. That is the time we laid our plans for expanding the dealer's service training program. It was done so that we would have men with months, if not years, of practical training and experience to diagnose and recondition farm equipment. The present nation-wide program to repair and service all farm equipment verifies our vision, in part, of last year. We have, however, lost some of these trainees to military service, and many of the rest had not completed training but yet we have gone a long way in enlarging the farm machine service organization.

3 *High School Student.* A word about training high school students for the first job, and again I limit this in so far as it affects our industry. The Out-of-School Youth activity part of the National Defense training program has offered the first practical training to farm boys in operating and maintaining the equipment they use. We have had shop training, to be sure, but it has not been on a practical basis. Personally, I believe the Out-of-School Youth program has a great deal of merit, and I hope that the same type of training will become standard in all Smith-Hughes schools.

OPPORTUNITY FOR AG ENGINEERING DEPARTMENTS TO OFFER ANOTHER SERVICE TO AGRICULTURE

If this is to be realized, then the departments of agricultural engineering are faced with the responsibility of training teachers who in turn can teach for the first job. With proper analysis, I am sure the departments appreciate this splendid opportunity for expanding their work and at the same time offering another worth-while service to agriculture.

Before going into the organization and technique of our training program, I would just like to mention the present-day needs in the military. This present war is really an internal-combustion engine war. With division after division comprised of motor vehicles, it is obvious that all the operators and a sizable number of the other personnel should have some working knowledge of motor mechanics. Some divisions of the military, realizing the immediate need for this, have called upon industry to assist in providing the instruction. This has been done both in this country and in Canada with satisfactory results.

Now, briefly to the third and final part, namely, organization and training techniques. First, a word about industry objectives compared to academic institutions. All men in training have been selected as having definite possibilities, so we endeavor to improve every man as much as possible — we do not want to flunk any one. These men are to be trained in service stations, one and two — never more than three at one location. It is up to the educational division of respective organizations to decide (1) what operations make up the total job, (2) what instruction concerning these steps should be given, (3) in what order the trainee should master the steps in learning a job, and (4) what methods of instruction should be used.

An individual job requirement analysis is used for this. The analysis has two vertical divisions, namely, (1) what operations or processes are included in the job, and (2) what the student needs to know in order to perform it intelligently.

With the above information for each student, the local organization and procedure for each training school is established on the following basis:

1 One person is selected as the trainer who is definitely responsible for the instruction.

2 This trainer or teacher must be qualified to do the training. He must know how to do the work he is to teach, and he must know how to train the worker efficiently.

3 There must be an organized plan for training—a definite scheme so the worker masters the procedure in steps best suited to his learning ability.

4 Adequate time for training. Sufficient time should be given the worker to learn to perform the manipulated processes to meet production requirements—never hurry him or have him compete with a flat-rate schedule.

SAFETY EDUCATION SHOULD BE A VERY DEFINITE PART OF ALL TRAINING PROGRAMS

The instructor will want to know how he acquired the skills he will pass on. He will discover he has formed a habit of performing such processes with a minimum of time and effort. He will find he does the work primarily from habit. The question then is how shall this know-how of habits be passed on.

Habit formation follows some very simple rules:

1 The worker is given to understand exactly what he is to learn or do.

2 He is taught by demonstration and explanation how to do this work and why he does it that way.

3 He practices the operation correctly from the beginning and is never allowed to do it any other way, not even under speed-up pressure.

4 He is watched so that any fault in his performance may be corrected immediately.

5 His work is checked from time to time.

6 He is kept under supervision until the proper work habits become so fixed they are automatic. No new job is started until the previous one has been completed satisfactorily.

And now a word about safety. Safety education is a very definite part of all our training programs. Accidents are the result of mistakes. Little mistakes can make big accidents. A mistake, little or big, is the result of incorrect performance, mental or physical. Accidents are costly. They result in increased production costs, poor quality of work, confusion, loss of time, and possible injury.

The only time to train a person in correct operations and safety actions which he is to observe and perform on the job is from the very start; otherwise, he may perform incorrectly and practice unsafe actions which will have to be unlearned later. Instructors, whether in the plants or service stations, should not start new workers first by teaching them to do the job and then later trying to teach them to work safely.

The time to establish safety habits in any worker is during the learning period. Safety is taught not merely as an adjunct to the proper performance of a task but as an integral part of the performance.

This training program may appear like a big order, especially with training in progress at so many locations under as many trainers. It would not be if world and national conditions were normal. We have had to make many changes quickly during the past few months. However, with the proper teacher, a definite job requirement analysis, proper instruction material, and a definite outline we are finding it works. And I believe I am safe in saying that after this war ends industry will be permanently job-training conscious.

Soil Movement within the Surface Profile of Terraced Lands

By A. W. Zingg

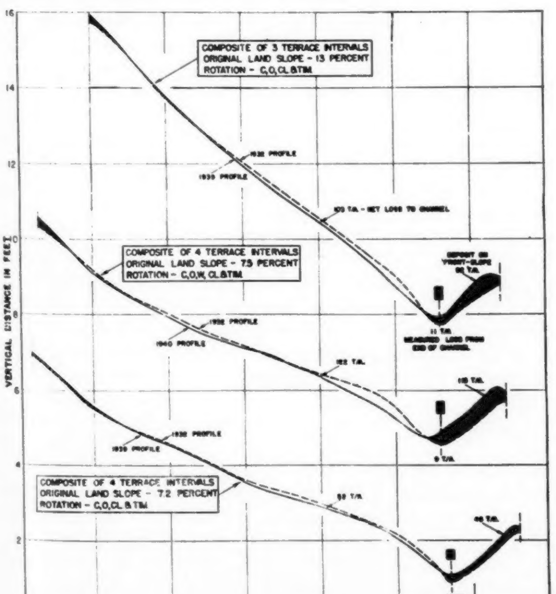
MEMBER A.S.A.E.

A STUDY of soil movement on terraced slopes was started in 1932 at the Soil Conservation Experiment Station located on Shelby loam soil at Bethany, Missouri. It was recognized early that soil loss from terraced lands, as measured at the end of the terrace channel, gives little indication of the physical change within the surface profile of the terrace interval. The measurement of soil movement on the profile interval, combined with records of soil loss from the end of the channel, approaches study of the problem in its entirety.

A soil movement line was established on each of three terraced fields in 1932. Permanent bench marks were constructed on the upper and lower reaches of each slope. A steel tape, drawn taut by 16 lb tension between the bench marks, was used to secure profile readings of the surface elevation of the soil at one-foot-slope distances. These readings were secured annually from 1932 to 1936, and have subsequently been secured once, during the rotation cycle, when the fields were in meadow.

Changes occurring in the surface profile, from year to year, were found to be too small to be measured accurately by the method of precise leveling. Irregularities caused by cultural operations also dominated the readings taken on successive years, or for short time intervals. Bench marks were found to change in elevation from time to time, and the entire soil body contracted and expended with moisture and temperature changes, thus rendering the data secured of very little apparent value. By studying the changes over a longer period of 7 or 8 years, combining data from parts of each soil movement line, and adjusting general elevation differences occurring throughout the entire length of the surface profiles, it is believed a good estimate of the phenomena can be attained.

Paper presented before the American Society of Agricultural Engineers at its fall meeting at Chicago, December 1941. Author: Assistant agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (NOTE: This paper is based on cooperative soil and water research by the Missouri Agricultural Experiment Station and the office of research, Soil Conservation Service, U.S.D.A.)



Composite profiles showing soil movement in adjacent terrace intervals on different slopes

Adjusted elevation and composite profile readings of 1932 and 1939 were made for terraces cropped to a 3-year rotation of corn, oats, clover with timothy. The original land slopes before terracing were 13.0 and 7.2 per cent. Readings from 1932 to 1940 were also adjusted and composited for terraces cropped to a 4-year rotation of corn, oats, wheat, clover with timothy, on an original 7.5 per cent slope.

General elevation differences due to extraneous factors were adjusted to meet the following condition:

$$\Sigma a - \Sigma b - lc = 0$$

where Σ = sum; a = each 1932 elevation, reading in feet, at one-foot slope distances; b = each elevation, reading in feet, at one-foot slope distances in 1939 or 1940; c = average depth of soil loss in feet, over the length of soil movement line used in the study, as calculated from measurements at the end of the terrace channels; and l = slope length in feet of the portion of the entire soil movement line utilized for the study.

Thus the resultant sums of elevation differences for the time period were considered to be due only to the loss from the terraced field by the terrace channel. This implies that no net gain or loss on the terrace intervals studied would be occasioned by soil passing down the slope over the terraces. This assumption is thought to be justifiable, since only adjacent terraces located on the central portion of the slopes were composited and other terraces were presented on the upper slope reaches.

After adjusting elevations, as outlined above, a continuous section of the soil movement line, to be composited into an average profile for the terraces involved, was plotted on cross-section paper. The terrace profiles to be composited each were divided into two parts, one consisting of the line from the center of the terrace ridge above to the center of the channel below, the other covering the remaining terrace front slope from the channel to the ridge. The 1932 data were used as the basis for this division. The sections of the terraces to be composited were then bisected repeatedly with a compass into thirty-secondth parts. The average readings of the points, thus attained from the corresponding proportional locations on each terrace, were replotted to form the composite profile.

The resultant adjusted and composited profiles, determined as previously explained, are plotted in the accompanying figure. They are composites of three adjacent terrace intervals on the 13 per cent slope, and of four adjacent terrace intervals on the 7.5 and 7.2 per cent slopes, respectively.

DISCUSSION

A marked parallelism exists between the changes in surface profiles for each of the three composite terrace intervals illustrated in the accompanying figure. All show a slight building up on the back slope of the terrace ridge, soil movement in increasing amounts with increases in slope length to the terrace channel, and deposition on the front slope of the terrace berm.

The amount of soil movement is dependent primarily upon the land slope and the cropping system. The center lines of the channels and ridge tops also have moved vertically and horizontally up the slope, by an amount roughly proportional to the fill that has occurred on the front slope. The net loss of soil over the interval from the upper ridge location to the channel and the net deposit on the front slope of the terrace berm were calculated from the 1932 locations of ridges and channels. The figures given are in tons per acre from the entire slope length of the composite profiles, calculated on the basis of one surface inch of soil equaling 150 tons of soil per acre. The soil loss, as measured from the end of the terrace channels and plotted to scale immediately above the center line of the 1932 location of the channels, was calculated on a similar basis. It is found to represent only a small part of the soil movement that has occurred on the profile intervals.

Evaluation of the amount of soil movement that has taken place, or will subsequently take place, to successive terrace intervals is subject to the personal equation. It is apparent that, if the 1932 locations of the channels and ridgetops had been maintained, the entire deposition, at present retained on the ridge front slopes, probably would have been moved down the slope to the adjacent terrace interval. Since their locations have not been maintained, the terrace intervals have progressed up the slope, thus interchanging soil from one interval to another by an amount approximating the loss as measured at the ends of the terrace channels. One-way plowing, in which the furrow slice is moved up the slope and the deadfurrow placed in the terrace channel, has been in practice on the fields since 1933. The deposition immediately below the old ridge location is thought to be due to the method of plowing and not to movement over the ridge.

It is apparent further that a continuation of soil movement, as it has here occurred, projected into the future will ultimately result in a bench formation. This is undesirable on lands having relatively shallow coverings of topsoil, since the more fertile soil will collect in the ridges and subsoil will be exposed on the intervening benched areas leading to reduced crop yields[1]. In addition to plowing up slopes, soil will have to be moved periodically from the front slope and redistributed by mechanical means on the slope above, or over the ridge to the slope below, if benching is to be prevented. This could be accomplished by throwing the fill material up slope with a whirlwind terracing machine, although adjustment of the rotor position possibly would be prerequisite. The deposition also could be bladed over the ridges and distributed over the adjacent lower intervals; however, this approach would defeat its purpose, as the topsoil would eventually be removed from the slope.

Soil movement within the terrace interval has undoubtedly decreased in rate since the initiation of the experiment, due to cultural practices, soil treatment, and the smoothing out of former abrupt changes in the surface profile by the operation of farm machinery. It is interesting to note that the average slope of the lands has been increased from 13 to 16.8, 7.5 to 11.6, 7.2 to 11.4 per cent, respectively, as measured from the three composite intervals of the accompanying figure.

[1]Zingg, A. W., and Whitt, D. M. Distribution of corn yields on farm terraces on the Shelby soil. (EDITOR'S NOTE: This article will appear in the next number of AGRICULTURAL ENGINEERING.)

SUMMARY

Soil movement on and from three terraced fields for 7 or 8-year periods has been studied by compositing three or four terrace profiles on each field.

A marked parallelism was found to exist between the surface profile changes that have occurred in each field.

Soil loss in run-off, as measured at the ends of the terrace channels, represents only a small portion of the soil movement to the terrace channels.

Soil has been transferred from a terrace interval above to a lower adjacent interval by progression of the ridge location up the slope. The amount of such interchange has approximated soil loss from end of terrace channel.

Present cropping practices and farming methods are leading to a condition of benching between ridges. The undesirability of this formation on Shelby and similar soils and possible corrective measures are discussed.

Discussion by Donald Christy*

THE measurement of interterrace soil movement is a difficult problem. Bench marks set 3 ft in the ground may rise and fall as much as 0.1 ft per year. Likewise the surface of the soil may rise and fall 0.3 ft per year due to changes in the amount and location of the soil moisture. The incorporation of straw or green manure may increase the elevation of the surface. The loosening of the ground by plowing or the furrows caused by row crops all complicate the measurement of soil movement.

Mr. Zingg's conclusions are based on a number of years of research. The change in profile elevations over a period of years should tell much about soil movement. The Bethany experiment indicates a soil loss down the slope to the bottom of the field equal to the loss of soil at the outlet. This is true even though a two-way plow has been used to move the dirt from the channel back toward the terrace above. The data from one of the Texas experiment stations show that the movement down the slope is about equal to the amount of dirt turned up hill by a two-way plow. The Texas slopes are, however, less than those of the Missouri experiment station.

The fact that the terrace body moves up hill is valuable. If a terrace outlet is more or less fixed while the rest of the terrace moves up hill, the gradient will be increased. This explains the observed increase in terrace gradient along some old terraces even though the outlet was fixed.

The farmers of the Southeast United States claim that their terraces move up hill a little each year. The Texas terraces do not appear to move up hill to any great extent.

Data is not available, however, to prove or disprove this contention. The difference in slope between the terraced land of the Southeast and of the Southwest is considerable. The Southwest slopes are about one-half those terraced in the Southeast.

The tendency of terraces to bench might be studied in another way. The profile of the field of old terraces is taken from the top of the hill to the bottom of the field. The rod readings are made every two or three feet, except across the terraces where they are made on one-foot stations. The profile is then plotted with an exaggerated vertical scale. A tendency to bench even one or two inches becomes evident. Our research on local terraces 10 to 15 years old show no measurable benching.

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Improved Row System for Terraced Fields

By T. L. Copley

CONTOUR tillage is one of the principal erosion-control measures for cultivated crop land. It is included in the majority of soil conservation farm plans, and is recommended generally by most agricultural workers. It is an excellent companion measure for terraces, and the effectiveness of each practice is increased materially when they are used together. Terraces serve as a guide for contour tillage and as an outlet for the water draining from crop rows in the intervals above.

The practice is almost as old as American agriculture. In some of the letters of Thomas Jefferson, as well as in other records of early American agriculture[1,2], it is indicated that the practice came into general use during the early part of the 19th century. These records also indicate that there was some criticism of the practice because the capacity of the furrows was not enough to hold the water during heavy rains. When the ridges broke, the accumulated water caused serious washing. While the use of contour tillage has greatly increased since that time, the same criticism is still made. The damage from concentrated row water sometimes more than offsets the benefits of contour tillage.

There are several requisites of a good row system: (1) The rows should be near enough on the contour to collect and retain a large part of the rainfall, thus reducing run-off and soil loss. (2) Since, as indicated above, they will not be able to hold all the water from a heavy rain, they should have a continuous grade in the same direction, so that the ridges developed in the process of cultivation will act somewhat as miniature terraces or diversions, and carry excess water to the row outlet. (3) For crops such as tobacco, they should have sufficient grade to prevent ponding and provide adequate field drainage. (4) For ease in cultivation, rows should be as long as practicable.

When laying out rows on terraced fields, it is customary to use either one terrace or the other as a guide, with point rows filling in where the terrace widens. Several types of row arrangement between terraces have been used. In parts of the South it has been the practice to have a portion of the rows in a terrace interval parallel the upper terrace, and a portion parallel the lower terrace, with all point rows in the middle of the interval. In other sections it has been recommended that all rows of the interval parallel the upper terrace, with point rows emptying into the channel below.

While both systems have their advantages, neither one is entirely satisfactory for average field conditions. The most common difficulty is that slope changes and field irregularities cause a reversal of the grade of the rows, which results in ponding or row breakage, with rilling or gullying and terrace silting. These silt deltas, deposited in the channel, may either greatly reduce the terrace capacity or cause them to break over and do material damage to the field below. Terrace maintenance in such cases usually is heavy, and frequent attention is necessary. While this trouble may be experienced on most terraced land, it has been observed particularly on the bright tobacco land of the Piedmont.

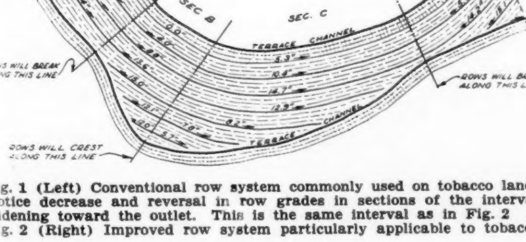
As has been indicated, it is highly desirable for each row to carry its own water to an established outlet. This will be impossible, however, unless a positive or continuous grade is maintained on each row from the crest to the outlet. It is known that the grade of rows is not determined alone by the grade of the terrace which they parallel, but also by changes in field slope. This is illustrated in Fig. 1, where it may be noted that the grade of rows, when parallel to the upper terrace, equals or exceeds the grade of the terrace only if the interval is narrowing toward the outlet, as in Section C. The row grade decreases and reverses if the interval widens toward the outlet. This reversal of grade causes a concentration of row water from both directions at approximately the narrowest point of the interval with row breakage and channel silting at that point.

This relationship between change of slope, or the change in width of the terrace interval, and the grades of the rows within the interval provides a means of getting the desired continuous grade and preventing the reversal of grade in the rows. To accomplish this, the rows must parallel the upper terrace in sections of the interval narrowing toward the outlet and parallel the lower terrace in sections widening toward the outlet. Theoretically, the grade of all rows then will equal or exceed the grade of the terraces. Observations show that this method works under field conditions, except where small gullies or other abrupt changes in the topography interfere. Fig. 2 illustrates this improved row system, and it may be noted that the rows parallel the upper terrace in Sections A and C, which are between con-

Paper presented June 23, 1941, at the annual meeting of the American Society of Agricultural Engineers at Knoxville, Tenn. Author: Project supervisor, soil conservation experiment station (Raleigh, N. C.), Soil Conservation Service, U. S. Department of Agriculture.

[1]Hall, A. R. Early erosion-control practices in Virginia. U. S. Dept. Agr. Misc. Publ. No. 256, 1937.

[2]Hall, Arthur P. The story of soil conservation in the South Carolina Piedmont, 1800-1860. U. S. Dept. Agr. Misc. Publ. No. 407, 1940.



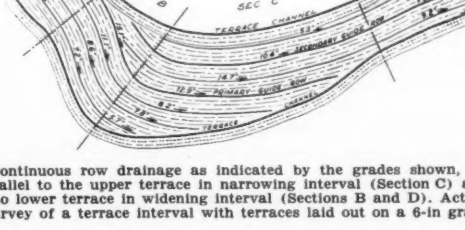


Fig. 1 (Left) Conventional row system commonly used on tobacco land. Notice decrease and reversal in row grades in sections of the interval widening toward the outlet. This is the same interval as in Fig. 2 • Fig. 2 (Right) Improved row system particularly applicable to tobacco fields. Continuous row drainage as indicated by the grades shown, by rows parallel to the upper terrace in narrowing interval (Section C) and parallel to lower terrace in widening interval (Sections B and D). Actual stadia survey of a terrace interval with terraces laid out on a 6-in grade

verging terraces, and parallel the lower terrace in Sections B and D, between diverging terraces. The grades shown were found by actual plane-table survey of the interval.

Laying Out the Guide Row. If the principle of this system is clearly understood, laying out the rows is relatively simple. A single guide row is first marked off, and all other rows parallel this guide row. As has been indicated above, this guide row, beginning at the crest of the upper terrace, should parallel the upper terrace in narrowing sections and the lower terrace in widening sections.

Since this guide row may parallel first one terrace and then the other, it has been found desirable to use three persons and a cord or twine long enough to more than reach from one terrace to the other. After the crest of the terrace is located, man number 1 takes his position opposite the crest where the first row below the terrace should be. Man number 2 places himself in the upper channel with one end of the cord, while man number 3 places himself in the lower channel with the other end of the cord. Man number 1 holds the cord at his point and establishes the location of the guide row as they proceed toward the outlet end of the terrace interval. He parallels either terrace desired by keeping the cord tight against the man he wishes to parallel.

It will be noticed that the guide row, as well as all other rows, tends to work down hill. Thus man number 1 may pull away from man number 2, but never closes up on him. Likewise he closes on man number 3, but never pulls away from him as they proceed toward the outlet. The completed row system is shown in Fig. 2.

A fourth man with the row marker may follow directly behind man number 1, or stakes may be set along the line of the guide row. A guide row is established for each terrace interval, and the row system is completed with all rows in each interval parallel with the guide row.

THE GRADE OF THE ROWS WILL BE INCREASED IN NARROWING OR WIDENING INTERVALS

To avoid plowing down the terrace ridge, all rows above the guide row should begin below the terrace ridge, rather than cross it to the channel above. It is thought best to lay off at least three rows on the ridge for the full length of the channel and have a narrow turn row immediately below these wherever point rows end.

As previously stated and shown on the accompanying field diagram, the grade of the rows in such a system will be increased in narrowing or widening intervals. In sections of the intervals where the terraces are approximately parallel, however, the row grade will not greatly exceed that of the terraces. The row grade should be increased through these sections, either by the use of an instrument or by simply dropping gradually down hill with the guide row.

There are two possible criticisms of this system. Cultivating and harvesting the point rows on the upper side of the interval necessitates either turning against the long rows on the terrace ridge, leaving the ridge out of cultivation, or extending the point rows across the ridge. The farmer must decide which practice best suits his situation. In either case, care must be taken to maintain the effective height of the terrace. The other criticism may lie in the fact that the row grades may be less in one section than in the adjoining section above it, as is the case with Sections B and C of Fig. 2. This should cause no serious trouble, and it would be rather difficult to avoid it. The grades of Sections B and D could be reduced by having the point rows interspersed between the long rows where the interval widens. This, however, would make cultivation rather troublesome.

It is frequently the case that permanent depressions,

Fig. 3 A terrace interval study of winter ridging showing rows laid out using string method, as viewed from outlet end of rows and terraces of improved row system on terraced tobacco field. Notice that rows parallel lower terrace in foreground where the interval is widening toward the outlet. If they had paralleled the upper terrace all the way, they would have over-topped at the narrow section of the interval or near the bend of the lower terrace

small gullies, or other eroded places will occur in cultivated fields, into which row water will empty regardless of the row system used. Such places should be seeded to permanent vegetation and used as outlets for the row water. If this is done, some of them may be encouraged to fill up and smooth over so that rows may again be carried across. On many fields, it may be found that after these small gullies and other depressions are vegetated and can be used as small waterways, they may take care of grade reversals and row breakage. In these instances, all rows may parallel the upper terrace, since this will eliminate the ending of point rows just below the terrace ridge.

The improved row system, or "string method", as it is sometimes called, was first tried during 1936 and 1937 on tobacco fields in the Bannister River demonstration project area of the Soil Conservation Service, near Danville, Virginia. It has since been studied further on a field trial basis on numerous farms of the tobacco-growing area; and the results have been sufficiently satisfactory for the tobacco field trial committee of Region 2 to recommend it for general use on tobacco land.

Tobacco is a critical crop from the standpoint of row drainage and soil washing, and this work on tobacco land has offered an excellent opportunity for determining the results and practicability of this row system. While it has been tried only with tobacco, results would seem to justify the belief that it has possibilities with other contour-tilled row crops.

Wherever row crops are grown on terraced land and laid out with either terrace as a guide, the numerous small furrows and ridges which develop during the cultivation process tend to conduct the surface water down the row. Continuous drainage, consequently, is desirable to reduce concentration from two directions, which causes rilling and terrace silting.

In the case of strip cropping without terraces, it appears that this system might be utilized to reduce concentration at narrow points. The rows gradually working down hill would empty at well-distributed points in the narrowing section, and on the sod strip below.

In view of the results of the "string method" of row layout on tobacco land, it would appear to be worth trying, at least in a small way, on other crops. It would be of particular interest to those who have been working with it to know the extent of its usefulness for other crops and in other sections of the country.

Drainage as a Conservation Practice

By Lewis A. Jones
FELLOW A.S.A.E.

SOIL conservation includes not only the protection of cultivated fields against soil erosion, but also the adjustment of land use to the purpose for which the land is best suited. Drainage, as one of the practices or phases of soil conservation, is no more important than other needed conservation practices, and its use depends on whether it will assist in bringing about the best land use for the area.

Land use and soil conservation measures, to be successful, must be adapted to the physical conditions of the land. The measures that are put into practice may be modified or controlled by other factors, such as economic and social conditions, but the foundation plan must be developed in accord with a physical inventory, particularly of soil conditions, topography, erosion conditions, and present land use.

In developing soil conservation programs, it should be remembered that the soil is not a dead, inert substance; it is a substance teeming with living microscopic bacteria that are essential to the production of crops. Some of these bacteria, working in symbiotic relation with legumes, change air nitrogen to fixed soil nitrogen, so that it can be used by the plants; others change organic nitrogen to the available nitrate form. These forms of bacteria, and countless others that are of equal importance in the soil processes, cannot function efficiently when the soil moisture content is too high. This is especially so in early spring when excess water hinders bacterial development by keeping the soil wet and cold.

When spring work is delayed by wet fields, the early crops are planted hurriedly in poorly prepared soils that lack aeration and are still cold as a result of the excess water. Because the soil has not become warm, seed germination and early growth are slow, and the plants may be stunted seriously. We are all acquainted with farms on which entire fields are poorly drained or only partially drained—fields upon which the farmer expends as much labor, seed, and fertilizer as he does on his well-drained land, but on which the crops are generally limited and frequently fail completely. The cost of farming this poorly drained land is just as great, and frequently greater, than the cost of farming well-drained land, while the limited crop yield materially increases the average cost of production. Surely, under such conditions, sound land use and soil conservation programs require that consideration be given to the practicability of improving drainage conditions.

In planning a land-use program to conserve the soil on a farm, it is frequently desirable to recommend the transfer of cultivated crops from eroding hillsides to flat bottom lands. Before such change can be made effectively, it often is necessary to drain the bottom land. On many hillsides seep areas occur that make impractical the application of such soil-saving practices as contour cultivation, strip cropping, and terracing, until these seep areas have been drained successfully. Thus drainage frequently is necessary on both flat lands and rolling lands to make practical the application of the best soil-conserving practices.

Paper presented February 4, 1942, at a meeting of the Southern Section of the American Society of Agricultural Engineers at Memphis, Tenn. Author: Chief, division of drainage, Soil Conservation Service, U. S. Department of Agriculture.

In some instances the increased crop yields resulting from the installation of drainage improvements may make a farm an economic unit, where the total productivity is not high enough after other conservation and land-use adjustments have been applied. Numerous instances are on record where crop yields have been doubled or trebled by drainage, the cost of the work being returned in increased yields in two or three years.

The development of soil conservation plans for an area without giving consideration to the practice of drainage is as unsound as the planning of drainage improvements without regard to other soil conservation practices. We are all acquainted with drainage ditches that have been constructed only to be filled almost immediately by soil washed from the surrounding watershed. The ditches were needed, but the expenditure made in constructing them was wasted due to failure to take into consideration the need of other soil conservation practices to supplement the ditches. Areas have been drained without investigating soil conditions, only to find that after drainage the land was of no value for agricultural use due to infertile soils. Experience in drainage work has indicated clearly that other soil conserving practices are interrelated closely with drainage, and failure to recognize this fact has proved expensive on many drainage projects.

Few people realize the extent to which drainage has been practiced in the United States, nor the amount of wet, swamp, and overflowed land still remaining in the United States that is susceptible to development at reasonable cost. It is proposed therefore to give a brief history of the development of agricultural drainage in the United States.

Land drainage has had an important part in the development of American agriculture, and in the improvement of public health. It is estimated conservatively that more than 100,000,000 acres of fertile land have been added to the cultivated land area of the United States, or have been made more productive and profitable, by drainage improvements. The benefits to health are difficult to measure, but it is known from early records that malaria was generally prevalent in Illinois, Indiana, Michigan, and Ohio, where drainage is most complete, and that it is practically unknown in these areas today. The experience in the South, also, has been

that after drainage the extent and seriousness of malaria have generally been diminished.

Drainage of farm lands began soon after the first settlement was made. It was discovered early in the work that even in small undertakings several landowners frequently were interested, and it often was difficult to secure voluntary cooperation. When many landowners were concerned, it was practically impossible to secure unanimous action. This difficulty brought about the passage of laws that provide means for constructing necessary outlet drains and force all benefited landowners to pay their just share of the cost. The first drainage law of which there is authentic record was enacted by the Colony of Massachusetts in 1702.

A general drainage act was passed in 1804 in New York state, and several other states enacted similar laws at approximately the same time. Under these early acts the work done was limited in size and in many cases was done by the landowners themselves. In all cases it was paid for in cash, as the laws made no provision for incurring debts, but simply provided means for assessing benefits and forcing those benefited to pay a proportionate share of the cost.

LARGE DRAINAGE IMPROVEMENTS CALL FOR EXPENSIVE MACHINES IN ECONOMICAL CONSTRUCTION

As the drainage improvements grew in size, expensive machinery was required for economical construction, and it became necessary to employ contractors to handle the work. These contractors had to be paid at the completion of the work. As the landowners could not raise the large sums required, drainage development, for a time, awaited legislation that would provide means for adequate and proper financing. In 1879 Illinois passed its Levee and Farm Drainage Act, which permitted the district to issue bonds to be sold for cash to pay for the construction. These bonds were first liens on all assessed lands within the district, and provisions were made whereby the landowners had a period of years in which to pay the cost assessed against them and thus redeem the bonds.

Since 1879 practically all of the states have passed laws under which drainage districts can be established and financed under the supervision of the courts.

Prior to 1910 the organization of drainage districts requiring bond issues was confined primarily to the north central states, with a comparatively few districts in the alluvial area of the lower Mississippi Valley. The engineering problems were simple, the cost of drainage low, and the expense involved in putting the land into cultivation after drainage was small. The work proved very profitable and made possible the development of much of the most fertile land in the states in which it was located. The development continued, with few exceptions, on a conservative basis until about 1915 when the agricultural prosperity resulting from World War I led to the speculative development by drainage of cut-over lands and swamp areas during the period of high prices. A considerable number of these areas have encountered financial difficulties during the agricultural depression following 1920. On many of the projects the promoters failed to take into consideration such items as soil fertility, cost of clearing and developing farm units after drainage was completed, difficulties in obtaining settlers for the undeveloped areas, cost of maintaining drainage improvements, and need for the agricultural products to be grown, etc. In some areas the plan of drainage was incomplete or improvements were designed with insufficient capacity, so that large areas remained poorly drained and could not produce profitable crops without extensive additional work. In other areas the cost of drainage was excessive, and the landowners found it impossible to meet their drainage assessments from the income received from the land.

The extent of these ill-advised projects, while large, is but a small percentage of the area that has been successfully and profitably reclaimed by drainage, and the difficulties that have been encountered should not result in ignoring the possible benefits to the agriculture of the country in carrying on constructive development of the wet and overflowed lands that still remain throughout the country. Such development should be made a part of sound land-use policies, giving proper consideration to wild life, forestry, and recreational developments.

While a large majority of the organized drainage enterprises in the country have proved profitable and have resulted in the development of millions of acres of our most valuable agricultural land, there have been sufficient failures to indicate the need for guidance in the planning and carrying out of such enterprises. Many districts have been organized in comparatively small areas, based more on community needs and interest than on watershed requirements. No systematic procedure has been followed. Some districts have good drainage, while the drainage of others is entirely inadequate. Big ditches flow into little ditches, which in turn empty into badly congested natural channels or sluggish bayous. The cause of these adverse conditions is, in most cases, poor planning and piecemeal methods of drainage. Few districts have employed competent engineers, and many have no engineering plans of any kind. In many cases the size of the ditches is entirely inadequate, with the result that the land never has been drained. Some districts have been unsound projects from their very beginning because the soil was not of sufficient fertility to warrant development, or because the lack of control of erosion from surrounding hill lands made it impractical to maintain the drainage improvements.

FEDERAL ASSISTANCE JUSTIFIED IN DEVELOPING SOUND ENGINEERING PLANS FOR DRAINAGE

Such difficulties could have been avoided largely if federal assistance had been available to the local people in determining the desirability of the projects from the land-use point of view, in developing sound engineering plans, and in financing the project on a reimbursable basis. Federal assistance seems to be justified fully in view of the fact that drainage, in addition to benefiting the land immediately affected, promotes the public welfare by improving health conditions, increasing the general tax base, reducing the cost of maintaining highways, and adding to the value of surrounding properties.

Soil conservation has a very important place in our food for freedom program. In producing the increased crops demanded by the present emergency, there should be no wastage of our soil resources. All phases of soil conservation work are important in conserving our soil, but under the present emergency the improvement of drainage conditions on lands already under cultivation offers an immediate and effective method of increasing crop production without increasing the amount of agricultural labor and power required to produce the crop.

According to the records of the federal census bureau, there are approximately 21 million acres of land in organized drainage enterprises in the twelve southern states. Of this area approximately 5½ million acres that now are under cultivation require the rehabilitation of their drainage improvements before the land can be made to produce the crop yields its fertility warrants. The rehabilitation of the drainage improvements on this area is an effective method of obtaining increased crops.

Mechanical Injury in Threshing Barley

By H. H. DeLong and A. J. Schwantes
ASSOCIATE A.S.A.E. FELLOW A.S.A.E.

THE study of the effects of cylinder types and adjustments on the mechanical injury of barley, reported in this paper, was an attempt to find the causes of damage to barley kernels and to find the mechanical features and adjustments that would give adequate threshing without mechanical injury. The types of equipment now available were used, and where there was a wide range of adjustment, the limits of satisfactory operation were noted.

The development of new machinery was not a part of the problem. The purpose was to work with the existing types of machines now on the market and to secure practical working data for them. The research was done under actual field conditions. This procedure subjected the study to a great many variable factors such as are encountered in any kind of field experiment in which soil conditions, weather conditions, and plant characteristics play a part. While many of these were eliminated, some could not be entirely controlled. It is, therefore, necessary to interpret the field results in the light of these rather than to accept the data as absolute answers.

Barley used for feeding purposes need not be threshed in the same way as that which is to be used by the milling or malting trade. In fact, it is oftentimes desirable to thresh feeding barley rather severely to break off all of the awns so they can be blown out with the dust and chaff. This is true especially with the varieties of barley which have the rough awns.

The malting trade demands a barley which has no more than 4 per cent of mechanically injured kernels. There are other definite specifications of a malting barley, but the one mentioned becomes the direct responsibility of the combine operator or the thresherman. The maltster does not object to a few awns remaining on the kernels, or a few kernels adhering to each other, but he does object to kernels that are skinned, frayed, or broken.

The practical problem thus arises out of the fact that the feeder wants no awns left on and does not object to broken kernels, while the maltster wants no broken or skinned kernels but does not object to a few awns. It is the duty of the machine operator to know how to adjust his machine so he can thresh for the feeding industry or the malting industry.

The threshing cylinder accomplishes its work by impact of a fast moving part striking against a head of grain or by the reverse method of a rapidly moving head striking against a stationary concave part. Threshing is not done by a "rubbing" process as in the case of a burr feed grinder. This process would break many kernels. In all types of cylinders the clearance between the cylinder parts and concave parts should be greater than the diameter of the grain kernels being threshed.

The purpose of this investigation was to (1) study the types of threshing cylinders to find which one, if any, did superior work in threshing barley for malting, (2) study the effect of cylinder speed on the cracking of kernels and determine the workable limits for the various cylinder types, (3) study the effect of cylinder to concave clearance and determine the workable limits, and (4) observe all threshing and combining processes to note if there were any other major causes of mechanical injury to barley. Comparisons are made of the work done by (1) spike-toothed cylinders, (2) rasp bar cylinders, and (3) rubber-faced bar cylinders.

The field tests were designed to try out the three different kinds of threshing cylinders under conditions as nearly similar as possible. The tests were further planned to use as many cylinder-speed adjustments and concave-clearance adjustments as possible for each cylinder so as to determine the workable limits of each.

A barley field at the West Central Experiment Station of the University of Minnesota, at Morris, was used for the trials. This field had a medium stand of grain which had ripened evenly, was free from weeds, and was standing up almost perfectly. The tests were run on July 30 and 31, and August 1, 1941. During this period, the weather was clear, warm, and as uniform one day with another as one could expect. There was no rain, and there had not been for several days previous to the test period. Weather and temperature conditions were therefore uniform except for the usual fluctuations morning, noon, and afternoon.

A small, power take-off-driven combine which could be equipped with either a rasp bar cylinder or a rubber-faced bar cylinder was used. Since it was not possible to obtain a combine with spike-toothed cylinder, a stationary thresher was used, and a quantity of grain from the same field was cut with a binder and threshed a few hours later. It was felt that this method of handling the grain, while not identical with the method for the other two types of cylinders, was enough like it to make a good comparison.

For the combine trials, lands were cut of such size that one round with the combine harvested about 1/10 acre. A different adjustment of the cylinder speed or of the concave setting was made for each 1/10 acre. The tests were run in rapid succession so as to get as many tests as possible in a short time. Before and after each test, cylinder speeds and clearances were adjusted, checked, and recorded. A two to three-quart sample was made up from at least ten different places in the combine bin during the unloading process, and a small part of each sample was placed in vaportight cans which were later tested for moisture content and examined to determine the per cent of damaged kernels. Fifteen tests were made with the rubber-faced bar cylinder, twelve with the rasp bar cylinder, and nine with the spike-toothed cylinder. Observations were made after each test as to the apparent damage to the threshed grain and also as to the amount of unthreshed heads remaining in the straw. These observations were recorded. The data helped in the interpretation of results.

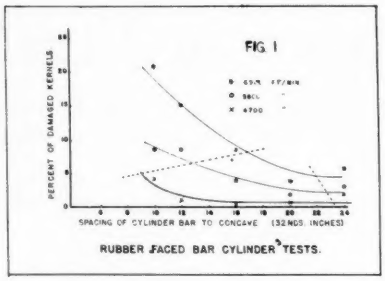
The portion of the field sample that was not placed in vaportight cans was used by the senior author to determine the percentage of broken and damaged kernels. Counts were made on four 100-kernel groups from each sample. The results of these determinations were later compared with those obtained by the Federal Grain Supervision of Minneapolis from that portion of each sample that had been placed in vaportight cans at time of combining. There was a very close agreement on 35 of the 36

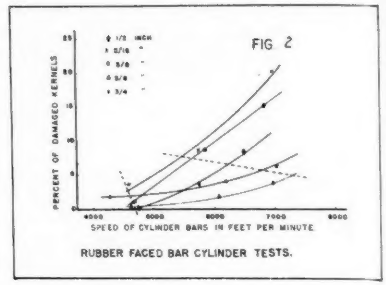
Paper No. 1466, Scientific Journal Series, Minnesota Agricultural Experiment Station. Specially prepared for publication in AGRICULTURAL ENGINEERING. Authors: Respectively, instructor and research assistant in agricultural engineering, South Dakota State College, and chief, division of agricultural engineering, University of Minnesota.

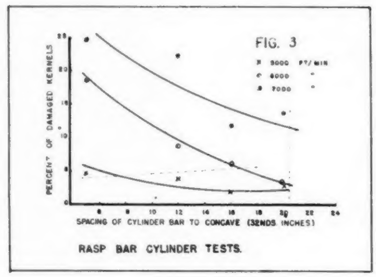
Figs. 1 and 2 With the rubber-faced bar cylinder, the best speeds were around 5000 fpm. Poor threshing resulted from lower speeds. Speeds to 6000 fpm could be used only for spacings of ½-in or larger

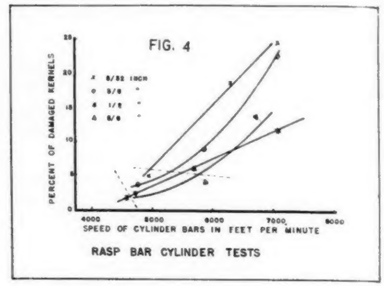
Figs. 3 and 4 Tests with the rasp bar cylinder showed that the best speeds were very close to 5000 fpm, and ⅜ and ½-in spacings resulted in best threshing without excessive cracking

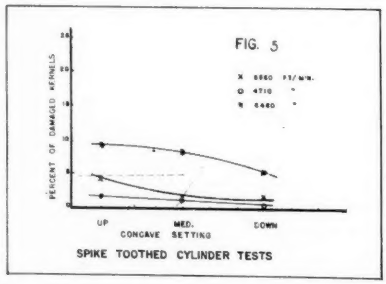
Figs. 5 and 6 Best results with the spike-toothed cylinder occurred at speeds from 4700 to 5500 fpm. While the quality of threshing was not always good at the slower speeds, excellent results were obtained with two rows of concaves set up as close as possible and a speed of 4710 fpm

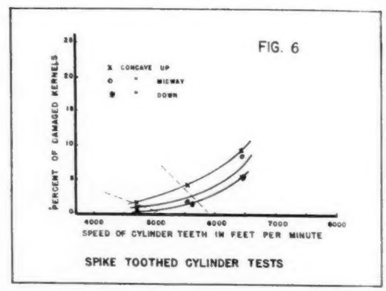












samples. Moisture determinations were also made by the Federal Grain Supervision.

In preliminary tests of cylinder speeds, it was found that the speed while threshing was about 8 per cent less than when the machine was running idle. Several speed determinations were made for each setting. These were taken when the machine was not threshing and were reduced by 8 per cent to obtain the assumed actual operating speed in each case.

Figs. 1 and 2 show the results of the 15 tests made with the rubber-faced bar cylinder in the combine. Five different spacings were used with each of three cylinder speeds. The cylinder speeds are given as linear speed of the bar or tip of the tooth.

The best threshing job resulted from a combination of clearance and speed adjustments which fall between the dotted lines on the graphs. This area roughly includes speeds between 5000 and 6000 fpm (feet per minute) and clearances between ½ and ⅝ in. As the speed increases the permissible clearance decreases. Too much damage to kernels was caused at speeds over 6000 fpm for most clearance. Large clearances and low speeds, outside the area indicated in the graph, were unsatisfactory because they permitted unthreshed heads to go through.

In Fig. 2 it will be noted that the ¾-in line occurs above the ⅝-in line. This is likely due to the fact that the ⅝-in clearance tests were run from 10:00 to 11:30 a.m., and the ¾-in tests were run from 3:30 to 4:30 p.m. In the drier part of the day the ¾-in clearance caused slightly more cracking than did the ⅝-in clearance earlier in the day. This indicates the effect of moisture content. It was not possible to get a complete set of data with moisture content the only variable.

The rasp bar cylinder test results are plotted in Figs. 3 and 4. The speeds used in the twelve tests ranged from 4500 to 7000 fpm. Most of them centered closely around 5000, 6000, and 7000 fpm. The clearances, from the concave to the tip of the rasp bar serrations, as shown on the graphs, ranged from 5/32 to ⅝ in with an average of 9/32 in. The clearances from the cylinder-bar valleys between serrations to the concave ranged from 13/32 to 28/32 in, with an average of ¾ in.

The best speeds were very close to 5000 fpm and the ⅜ and ½-in clearances gave the best threshing without excessive cracking. The performance curves of the rasp bar cylinder is quite similar to the rubber-faced bar cylinder.

The curves in Figs. 5 and 6 represent the results of the spike-toothed cylinder tests. Here the lateral clearance could be varied only 2/32 in (from 5/32 to 7/32 in), but the vertical adjustment permitted setting the concave frame up close, down or open, or midway between. This adjustment materially affects the areas of the tooth surfaces actually passing each other, and hence the threshing capacity. The cylinder speeds of the thresher could not be changed greatly; hence the speed curves are rather short in comparison with those on the other graphs. The speeds were approximately 4700, 5600, and 6500 fpm of the cylinder teeth.

The setting that resulted in smallest quantity of damaged kernels and best threshing for conditions as they were at the time, was a speed of 4700 to 5500 fpm and with two rows of concave teeth set clear up. Higher speeds result in clean threshing but also in more damaged kernels.

CONCLUSIONS

The speed at which the cylinders operate to do their best work ranged from 5000 to 6000 fpm for all three types of cylinders. Slower speeds leave unthreshed heads and higher speeds result in too much cracking and skinning.

The best clearance for the rasp bar cylinder was ⅜ to ½ in as measured to the tips of the bar serrations. The rubber-faced bar did its best work at a ½ to ⅝-in clearance. The spike-toothed cylinder did its best work with a lateral clearance between teeth of 5/32 in. The actual clearance cannot be changed much, but by raising and lowering of

concaves the areas of the tooth surfaces passing each other can be greatly changed.

To effect minor changes either cylinder speed or concave clearance can be changed. For major changes in operating conditions, however, it is necessary to adjust both speed and concave clearance.

The three cylinder types were carefully compared as to their ability to thresh barley properly without cracking more than 3 or 4 per cent. It can be readily seen from the test data that all three types (1) can be adjusted to thresh properly, (2) can be set to let heads go through unthreshed, or (3) can be set to thresh too severely and cause much mechanical injury to the kernels.

After considering all data in the light of observations and operating conditions, it is believed that the rubber-faced bar cylinder has a slight advantage in threshing adequately and yet not cracking the barley kernels.

RECOMMENDATIONS

One can hardly work with machines without seeing some opportunity for improvements in design or practice. It is recommended that the combine or thresher operator who is threshing barley for either feeding trade or malting, must keep constant watch of the process. Conditions may change in a short time so that a readjustment of the cylinder is needed.

"Quick-change" devices would be of material assistance to the operator attempting to do good work under a variety of conditions. The cylinder speed should be capable of change in a few seconds and without affecting the other parts of the machine. The concave-clearance changing mechanism should not be one which requires the loosening and retightening of a number of bolts. It should be a strong simple device which will permit raising or lowering the concave grate in a few seconds. A dial on the outside of the machine showing the clearance measurement would help a great deal. Few operators, in the rush of harvest, will take much time out to make a cylinder or concave adjustment. The modern combine needs to be designed with possibilities for quick changing of cylinder speed and clearance between concave and cylinder. It should also have an indicator to show what the clearance is for any particular setting.

Mung Bean Production

By L. E. Hazen
MEMBER A.S.A.E.

THE mungo bean (*Phaseolus aureus*), usually called "mung bean", is closely related to the cowpea (*Vigna sinensis*) and the soy bean (*Glycine hispida*), all being cultivated for human food in China and Japan. All three are extensively grown in Oklahoma as soil and feed improvement crops due to nitrogen fixation in the soil and the high protein content of the seed. As yet, the forage is of minor importance.

The mung bean is growing in favor. It is more drought resistant than the soybean and easier to harvest than the cowpea. Two varieties are now grown, the golden and the green, the latter seeming to produce heavier yields of seed and grow taller, making it readily adaptable to combine harvesting.

Yields of seed range from twenty to thirty bushels per acre during favorable seasons on good ground. The forage yield is increased by sowing with the ordinary grain drill, but maximum seed production is obtained by drilling in rows with the corn planter, using a kafir plate.

The mung bean offers a wide choice in time of seeding; if planted early, it waits for the days with long hours of sunlight before setting seed, but does make tall growth with abundant foliage. When planted late, it merely grows less tall and sets seed promptly to avail itself of the long sunlit daytime; there is little difference in seed yield actually accruing if moisture is plentiful.

The seed ripens during quite a period of time. Therefore early cutting results in many green pods, while late cutting finds some shattering; yet this is less serious than with cowpeas, and mung pods seem quite adherent. Thus the total loss due to late cutting is about the same as with soybeans. In the only plot I have ever observed closely, few pods split while hanging on the vine although fully ripe, but the air dried pods after picking flailed out as readily as do cowpeas.

One method of harvest is to mow the beans late in the day, rake them into windrows before fully dried, then thresh them from the windrow. Pigs and poultry are glad to glean after the windrows are removed.

In threshing, the concaves are removed but all teeth left on the cylinder. Some cracking occurs unless the speed is reduced, and as a full blast of air is required at the raddles, most threshermen merely remove the concaves and depend on aftercleaning to remove dust and cracked grain. The small size of the seed and its nearly spherical shape, makes the fanning mill job simple.

A farmer, Paul T. Stritzke, Talala, Oklahoma, harvests almost exclusively with a small combine; he is considered an outstanding success in mung bean production and utilization by our experiment station staff. To date there is an increasing number of small acreages put in with the single mule and cotton planter, tilled with a Georgia stock, and gathered by hand. The beans are beat out with a pitchfork, fed to the various animals, the forage used for cows, and some folks say that properly cooked they make good food. I tried a few but have not yet generated an active appetite for them.

While now a minor crop, the mung bean should grow in importance and be free from such intricate problem of harvesting as is represented by cotton, castor beans, and vetch.

Paper presented before the 1941 annual meeting of the American Society of Agricultural Engineers at Knoxville, Tenn. Author: Head, agricultural engineering department, Oklahoma A. and M. College.

Eighth Annual Chemurgic Conference

THE Eighth Annual Chemurgic Conference of representatives of agriculture, industry, and science, under the sponsorship of the National Farm Chemurgic Council, Inc., will be held March 25, 26, and 27, 1942, at the Stevens Hotel, Chicago.

The general theme of the conference will be "Chemurgy in War". Some of the more important subjects scheduled on the program include the work of the USDA regional research laboratories; agriculture and the petroleum industry; food, farm machinery and war; industrial use of dairy products; plastics in wartime; corn products for war and peace; milkweed instead of kapok; drying oil requirements for war; domestic sources of essential oils; rubber for peace and war; recent castor bean developments, etc.

NEWS

President Kable Makes Extensive Trip

PARTLY in the interests of the American Society of Agricultural Engineers and partly in the interests of "Electricity on the Farm," of which he is editor, Geo. W. Kable, president of A.S.A.E., recently completed an extensive trip to the Pacific Coast, which included a side trip into the South.

Leaving New York on January 5, he arrived at Davis, California, on January 9, where he addressed a joint meeting of Pacific Coast Section of A.S.A.E. and the California Farm Implements Dealers Association. A total of about 350 men attended this meeting.

The program sponsored by the Pacific Coast Section was devoted quite largely to problems in connection with war programs including priorities, allocation of materials, training of workers for repair service, repair clinics, the bulk handling of grain, and the production of sugar beets. A great shortage of sacks and packaging material, Mr. Kable says, is going to cause some rather drastic changes this year in the methods of handling California crops.

The week following he attended the Rural Electrification Conference sponsored by the California Committee on the Relation of Electricity to Agriculture, and following this conference he spent some time at San Francisco and in Los Angeles and San Diego, and from there traveled to points in Oregon and Washington. On February 6 and 7 he attended the tri-state conference of rural electrification men from Oregon, Washington, and Idaho, which was held at Yakima, and while in Yakima he made a 15-minute morning broadcast to farmers as President of the Society.

Mr. Kable reports that at both the rural electrification conferences in California and in Washington, attention was given to methods of blacking out dairy barns and poultry houses and to those phases of the use of electricity connected with the war production program. The conference also included a review of all research activities in rural electrification and some of the war programs being carried on by educational institutions and various utilities in the rural field.

On the trip he also had an opportunity to visit the Grand Coulee Dam, and standing below the Dam, he says he was awed and impressed once more with the enormity of the possibilities the engineer's control of the forces of nature, which is true both because of the structure itself and the engineering accomplishments which the structure makes possible.

During the first three days of February, Mr. Kable was in Omaha and Lincoln, Nebraska, and while at Lincoln he spent considerable time with the agricultural engineering department of the University of Nebraska.

On February 4th and 5th he attended the Southern Section meeting of A.S.A.E. held at Memphis, Tenn., in conjunction with the annual convention of the Association of Southern Agricultural Workers where he addressed the Section dinner on the evening of February 5th.

Mr. Kable reports that most of the public institutions which he visited on his trip are rearranging terms and will continue courses throughout twelve months of the year. He states that all the agricultural engineers he met were placing war demands ahead of everything else, and that some of the research work under way will include the development of small dehydrators for fruit and vegetables on the farm, use of iron wire in place of nichrome for electric heating elements, and the development of various types of egg coolers.

Throughout his trip Mr. Kable continued to preach his philosophy that "the agricultural engineer is the man who puts a smile on the face of agriculture."

No Industry Seminar in 1942

IN view of the fact that the companies of the farm equipment industry that have cooperated with the American Society of Agricultural Engineers in the past, in sponsoring the A.S.A.E. Industry Seminar since 1938, are all engaged, more or less, in the production of war materials, and especially since government regulations would require virtually the complete closing of their plants to visitors, it is believed that an effective Seminar program could not be carried out this year and probably for the duration of the war.

It is for this reason that the decision has been reached to cancel the seminar activity for 1942 at least.

A.S.A.E. Meetings Calendar

April 3 - 4—Southwest Section, Caddo Hotel, Shreveport, La.

June 29 - July 1—Annual Meeting, Hotel Schroeder, Milwaukee.

November 30 - December 2—Fall Meeting, Stevens Hotel, Chicago

Southwest Section Meeting at Shreveport

THE meeting of the Southwest Section of the American Society of Agricultural Engineers originally scheduled to be held at Texarkana, Texas, will be held at Shreveport, Louisiana, instead. The change was made necessary due to congestion of hotel facilities at Texarkana on account of extensive war preparation activities in the vicinity. The dates of the meeting are Friday and Saturday, April 3 and 4.

The subjects and speakers for this program, for which definite arrangements have been made at this writing, include the following: Modification of Cotton Gin Machinery to Meet Present Conditions, by G. A. Gerdes, cotton gin extension specialist of Louisiana State University; Maintenance Problems of Terrace Outlet Systems, by T. J. Coyle, U. S. Soil Conservation Service; The Use of Electricity in Production Enterprises on the Farm, by P. T. Montfort, A. & M. College of Texas; Equipment and Fuels for Farm Home Heating, by Roy E. Hayman, Oklahoma Gas and Electric Company; The Removal of Brush and Prickly Pear from Range Pasture Lands, by Donald Christy, A. & M. College of Texas; the Possibilities of the Circular Roof Barn in the Southwest, by Price Hobgood, A. & M. College of Texas; Permeability Tests and Their Uses, by Kyle Engler, University of Arkansas; Results of Economic Studies by 4-H Club and F.F.A. Members, by C. F. Sturdevant, Oklahoma A. & M. College; Farm Machinery Depreciation, Service and Repair, by E. L. Barger, University of Arkansas; Prefabrication and Its Relation to the Postwar Farm Building Program, by Ray Crow, Tennessee Coal Iron and Railroad Co., and Dairy Barns for the Southwest, by J. L. Darnell, A. & M. College of Texas.

Other subjects listed, for which definite acceptance from speakers have not been obtained on going to press, include the following: Concrete without Steel in Farm Construction; Engineering Aspects of Rice Production; Revision of Present Shop Curricula for Emergency Needs, and Prefabricated Houses and Farm Buildings.

Members of the American Society of Agricultural Engineers, whether residing in the territory of the Southwest Section or elsewhere, are urged to make a special effort to attend this meeting; and the Section extends a cordial invitation to all nonmembers who may be interested in any part of the program, to attend the meeting and participate in the discussions. Complete information on the meeting, including arrangements, etc., may be obtained from the chairman of the Section, F. R. Jones, agricultural engineering department, A. & M. College of Texas, College Station.

Southern Section Holds Meeting

AN excellent program and a good attendance were two outstanding features of the meeting of the Southern Section of the American Society of Agricultural Engineers held at Memphis, Tennessee, February 4, 5, and 6, in conjunction with the annual convention of the Association of Southern Agricultural Workers.

There were 40 to 50 agricultural engineers, most of them from the Section area, in attendance at practically all of the sessions of the meeting. About 60 people, most of them A.S.A.E. members attended the Section dinner on the evening of February 5, at which Wm. E. Meek presided as master of ceremonies. President Geo. W. Kable was the speaker of the evening. His talk covered an interesting account of his trip to the Pacific Coast, from which he was just returning, and he also dealt at considerable length with the value of Society membership.

At its business meeting the Section elected the following officers for the year 1942-43:

Chairman, W. N. Danner, Jr., professor of agricultural engineering, University of Georgia. *(News continued on page 104)*

First Vice-Chairman, G. B. Nutt, professor of agricultural engineering, Clemson Agricultural College.

Second Vice-Chairman, F. M. Hunter, rural electrification specialist, Mississippi State College.

Secretary, G. E. Henderson, associate agricultural engineer, Tennessee Valley Authority.

In resolutions adopted by the Section, the need for the close cooperation of all agencies for increasing food production during the present world crisis was recognized, and the wholehearted support of the Section was pledged in the national food production program. Also, the scarcity of essential farm machinery and home equipment, including replacement parts, and the shortage of farm labor were recognized, and the Section pledged support and assistance to aiding farmers, local repair shops, and other agencies in the efficient repair, maintenance, and utilization of machinery and other equipment. The Section commended the War Production Board for its consideration in allocating materials for production of essential farm equipment and urgently recommended a careful reappraisal and reallocation of war material for the manufacture of essential farm equipment and repair parts to enable farmers to adequately meet the requirements of future food needs of the nation.

Promotion for George Krieger

THE Ethyl Gasoline Corporation, having recently merged all technical services to provide maximum cooperation between its research facilities and industry, and having provided for its special services to the tractor and farm machinery industry to be handled by an "Agricultural Division" in its new Technical Service Department, announces that George Krieger has been appointed general manager of the Agricultural Division. The Corporation also has organized a War Committee to adapt its extensive research facilities to the needs of the armed forces of the United States and to broaden the scope of its service to allied activities such as the production of foods and fibers.

The Corporation's agricultural division will operate from its new research laboratories in Detroit, and will have available all of the new laboratory facilities for research on fuels and engines on dynamometers, on the road, and in the field.

Mr. Krieger was graduated from Virginia Polytechnic Institute in 1926, where he was the first graduate of that institution to take what is now known as a professional agricultural engineering course, having arranged with the agricultural engineering department for a special cooperative experimental curriculum with which was incorporated basic courses of the engineering college. Following graduation, Mr. Krieger went to the research laboratories of the Standard Oil Company of New Jersey at the Bayway Refinery, and in 1929 he joined the Ethyl organization as agricultural engineer.

Mr. Krieger is a member of the American Society of Agricultural Engineers and has served as chairman of several committees, including fuels and lubricants, agricultural engine research, membership, and the meetings committee of the Power and Machinery Division. He is also a member of the Society of Automotive Engineers, and has served as vice-president of that society, chairman of its Tractor and Industrial Power Equipment Committee, chairman of its Meetings Committee, and also as a member of the SAE Council. Mr. Krieger was recently elected an honorary life member of the American Agricultural Editors Association.

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Sherman C. Heth, design engineer, J. I. Case Co., Racine, Wis. (Mail) 805 Lathrop Ave.

Ernest E. Jones, Jr., junior erosion engineer, Forestry Relations Department, Tennessee Valley Authority. (Mail) Box 918, Huntsville, Ala.

Pierre-Emile Roy, chief, farm mechanics division, Department of Agriculture, Quebec, P. Q., Canada.

Francis S. Todd, junior engineer, Soil and Moisture Conservation Operation, U. S. Indian Service, Phoenix, Ariz. (Mail) 1012 E. Fairmont.

TRANSFER OF GRADE

David W. Cardwell, associate hydraulic engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 607, Blacksburg, Va. (Junior to Member)

William E. Meek, special representative, International Harvester Co. (Mail) 276 Patterson Terrace, Memphis, Tenn. (Member to Fellow)

William J. Welker, instructor of agricultural mechanics, California Polytechnic School, San Luis Obispo, Calif. (Junior to Member)

Necrology

William Henry McPheters, extension agricultural engineer, Oklahoma A. & M. College, passed away suddenly at his home in Stillwater on February 18.

Mr. McPheters was a native of Missouri, and graduated from the Oklahoma A. & M. College in the electrical engineering course. In 1910 he became assistant professor of physics at the A. & M. College of Texas, a position which he held until 1921. In that year he obtained a degree in agricultural engineering from that institution, and was awarded the professional degree from the same institution ten years later.

During the first World War Mr. McPheters was an instructor in the Army School at the A. & M. College of Texas where he taught auto mechanics. In 1921 he returned to the Oklahoma A. & M. College where he became extension agricultural engineer until 1925, when he became a field agricultural engineer for the Portland Cement Association with headquarters at Oklahoma City. In 1931 he received appointment as head of the agricultural engineering department at Connecticut State College, where he remained until 1934, returning to Oklahoma to again become state extension agricultural engineer, which position he filled until his passing.

Mr. McPheters became a member of A.S.A.E. in 1921, and during the period of his membership, he was active on a number of committees, principally in the field of farm structures, in which he established quite a reputation as specialist in the use of natural building materials.

Mr. McPheters is survived by Mrs. McPheters, two sons and a daughter.

Personals of A.S.A.E. Members

U. S. Allison was recently appointed by the U. S. Soil Conservation Service as director of soil conservation work for Puerto Rico and the Virgin Islands, as well as assistant regional conservator for Region 2. For three years prior to this appointment he was in charge of engineering work for the SCS in the Hawaiian Islands, and for two years prior to that in charge of engineering work in Puerto Rico. He is an agricultural engineering graduate of the A. & M. College of Texas, and has been engaged in soil conservation work since 1933.

Earl L. Arnold was recently appointed to the position of mechanical engineer in the Farm Structures Division, Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture. Prior to this appointment he was head of the plumbing unit, Applications and Loans Division, R.E.A. His new address is Apartment D-431, 3004 N. Lee Highway, Arlington, Va.

Hobart Beresford, agricultural engineer, Idaho Agricultural Experiment Station, is one of the authors of Bulletin No. 241, entitled "The Production of Ethyl Alcohol from Cull Potatoes and Other Farm Crops," recently issued by that station.

Wallace J. Campbell now holds the position of junior engineer in the U. S. Soil Conservation Service at Glen Rose, Texas.

Walter M. Carleton has been transferred from his work in rural engineering extension to that of instructor in agricultural engineering at Kansas State College.

E. M. Dieffenbach, who until recently was associate agricultural engineer in the Bureau of Entomology and Plant Quarantine (USDA), was recently transferred to the Office of Agricultural Defense Relations of the Department, which is a planning, advisory, and liaison office set up within the USDA to serve and represent the Nation's farmers in the overall defense program.

F. C. Fenton, professor of agricultural engineering, and *C. K. Otis,* formerly instructor in agricultural engineering at Kansas State College, are joint authors of Bulletin No. 42, entitled "The Design of Barns to Withstand Wind Loads," issued November 1941 by that institution.

Robert H. Joyce is now camp engineer on the CCC Camp project SCS-A-25, and his address is Thatcher, Arizona.

Donald W. Kruse recently resigned as junior soil conservationist (engineering), U. S. Soil Conservation Service, and is now employed as apprentice engineer with the Boeing Aircraft Company, Seattle, Wash. (Personals continued on page 106)

James H. Lillard, assistant agricultural engineer, Virginia Agricultural Experiment Station, is one of the joint authors of Technical Bulletin No. 72, entitled "Effects of Slope, Character of Soil, Rainfall, and Cropping Treatments on Erosion Losses from Dunkore Silt Loam," recently issued by that station.

H. S. Pringle, agricultural engineer, Cornell University, has compiled Cornell Junior Extension Bulletin 60 covering rope work, power transmission, and soldering, especially for 4-H club members.

J. Roberts and *L. J. Smith* of the Washington Committee on the Relation of Electricity to Agriculture have recently compiled the 17th annual progress report of investigations of the uses of electricity in agriculture in the state of Washington. Mr. Roberts is also one of the authors of Bulletin No. 404, entitled "The All-Electric Greenhouse," issued September 1941 by the Washington Agricultural Experiment Station, Pullman.

Norman C. Teter who was formerly a research fellow in the agricultural engineering department at Iowa State College, is now an instructor in the department of engineering drawing at the same institution.

Russell Woodburn has been transferred from the position of station engineer of the U. S. Soil Conservation Service experiment station at Zanesville, Ohio, to that of project supervisor on the research project of the Service at State College, Miss.

Student Branch News

PENNSYLVANIA

By James B. Kistler, Scribe

THE Student Branch of ASAE at Pennsylvania State College held its regular semimonthly meeting February 2nd in the Agricultural Engineering Building. This was the time for the yearly election of new officers. Those elected for the coming year are as follows: Harry J. Hofmeister, president; Harold V. Walton, vice-president; George P. Replogle, secretary-treasurer; James B. Kistler, scribe; Prof. Ralph U. Blasingame, faculty advisor; Thomas F. Ford and Harold V. Walton, representatives to the Agriculture Student Council.

At the next meeting, February 16, Prof. John E. Nicholas discussed the research program in electroagriculture at Penn State. Prof. Nicholas, who has been connected with research here for the past twelve years, outlined his work from its start in a small corner of the old horse barn to its present fine laboratories in the new Agricultural Engineering Building. At first this research fell mainly under the title of "rural electrification", but now it has developed into more scientific phases so that Prof. Nicholas chooses to call it "electroagriculture". Some of the projects are egg cooling, milk cooling, electric brooders for chicks and young pigs, ultraviolet, infrared, sterilization, and power requirements for running silo fillers, feed grinders, and dairy manufacturing machinery. At the present time Prof. Nicholas is working on projects with the departments of poultry husbandry, animal husbandry, agronomy, and bacteriology.

The president announced the committee members for the new year and Prof. David C. Sprague read two letters which he had received from ag engineers who are now training with the U. S. Air Corps in Florida.

SOUTH CAROLINA

THE A.S.A.E. Student Branch at Clemson College ended the first semester with a series of talks given by prominent men in the educational activities of South Carolina. The first of these talks at the regular meeting of December 15, was given by G. H. Stewart, rural electrification specialist of R.E.A., who spoke on "Rural Electrification in the South." One of the most interesting things he brought out was the fact that the R.E.A. is going to be forced to stop building lines because of the present shortage of materials, but they are going to start an educational program in which the farmer will be taught the proper and efficient uses of electricity. After Mr. Stewart spoke, a short Christmas program was given by a group of A.S.A.E. members, after which everyone enjoyed an exchange of homemade tinker-toy Christmas gifts. While this was in progress, hot dogs and soft drinks were served.

At the first meeting of the new year, the Branch enjoyed an interesting talk by Col. Herbert M. Pool of the U. S. Army; Col. Pool is now the PMS&T of Clemson. He spoke on "The Present Conditions of the United States as the War Rages." One of the many interesting things mentioned by Col. Pool was that the United States has never lost a war but has never won a conference. He says that America must win this war, but still more important is the fact that America must also win the peace. Following Col. Pool's talk a short business meeting was held after which the meeting was adjourned.

During the past semester, the Branch has held six meetings with an average attendance of 77 per cent of the members.

GEORGIA

By Cecil S. Mize, Scribe

THE University of Georgia Student Branch of ASAE cancelled their regular meeting on January 12 to cooperate with the annual religion-in-life week on the University campus.

At the regular biweekly meeting on Monday evening, January 26, the Branch voted unanimously to buy defense bonds or stamps with any club funds appropriated for socials and to assess each man his share of the expense.

The Branch pledged 100 per cent support to the annual 4-H Club carnival to be held on March 16. The carnival is sponsored by the 4-H Club with the assistance of the other student organizations in the college of agriculture. Each club has a booth and sponsors candidates for king and queen of the carnival. The proceeds are added to a growing fund to aid deserving young men and women in attending college.

A very interesting quiz program was arranged by J. F. Eppes and the program committee. Suitable prizes were given to those who answered the questions asked them. After the program, the meeting turned into a general "bull" session.

The social committee has been asked to begin work on a big winter-quarter social function and all members are eagerly awaiting their report on possibilities.

TEXAS

By W. T. Hall, Scribe

THE agricultural engineering students at the A. and M. College of Texas no longer worry about what they will do each summer, as summers now mean another semester of school. The College has gone on a three semester basis with classes extending through the entire twelve months of the year. As it now stands, we have three semesters of sixteen weeks each with a week's vacation between semesters and a week's vacation at Christmas. The main purpose of this change is to allow the students to complete their education before reaching the draft age.

At one of our recent meetings, Mr. E. R. Eudaly, who is connected with the agricultural extension service at the College, gave us the complete history of the trench silo in the South; incidentally, he is responsible for the development of this cheap and simple way to put up feeds. This type of silo is now leading all others in the South because of its simplicity and economical construction.

Another speaker of interest was Mr. Virgil V. Parr, principal soil conservationist, USDA Soil Conservation Service. He discussed the engineering problems he encountered while managing a large ranch here in Texas.

Usually each year the graduate students in the department are in charge of one program. Two of our graduate students from Brazil discussed and showed pictures of several trips they have taken since coming to this country. They had a number of pictures taken while on the senior inspection trip to Dallas this fall; they also showed several pictures taken on their trip to Mexico City during the Thanksgiving vacation. The showing of many pictures in technicolor of our every-day campus activities concluded the program.

On the Saturday of February 28, couples dressed in overalls and patched shirts will be seen going toward the Agricultural Engineering Building. Yes, the annual Barnyard Frolic is drawing near. To conform with the changes made at the College in the method of conducting social functions, the profits from the dance will go to the student activities fund. The dance will be put on as a Corps dance, but the Agricultural Engineers are still responsible for it. At our last meeting all the committees for the dance were announced. A few nights before the dance, we will have a special meeting and clear the equipment from one of our farm machinery laboratories. This space, consisting of 14,800 square feet, will be decorated with lanterns, hay, and other appropriate items for this type of dance. This is one of the main social events here at the College, and in past years it has not been uncommon to have over 600 couples at our dance.

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, assistant chief, Office of Experiment Stations, U. S. Department of Agriculture. Copies of publications reviewed may be procured only from the publishers at the addresses indicated.

MEASUREMENT OF ELECTRODE POTENTIALS AND POLARIZATION IN SOIL-CORROSION CELLS, *R. B. Darnielle*. Jour. Res. Natl. Bur. Standards, Washington, (U. S.) 25 (1940), no. 4, pp. 421-433, figs. 4. Electrode potentials in soil-corrosion cells cannot be measured accurately by the direct method because of the high resistance of soils and because of the nature of the electrolyte and the electrodes. Measurements made with a mechanical interrupter are also in error because of depolarization during the period of interruption. By using an electronic circuit to interrupt the current for intervals of the order of 10^{-5} sec and a separate electronic circuit to measure the electrode potentials within this period of interruption, results accurate to about 0.01 v over the range of current, resistance, and rate of depolarization of soil-corrosion cells were obtained. These results were obtained with steel electrodes and in seven soil types and an unidentified alkali soil as the corrosion media. Although the modifications introduced into the method were for the purpose of adapting it to measurements in soils, it appeared that the method as modified would be well adapted to such high-resistance solutions as natural waters, particularly in potential measurements on metals which naturally develop high-resistance films.

MAXIMUM DISCHARGES AT STREAM-MEASUREMENT STATIONS THROUGH DECEMBER 31, 1937, *G. R. Williams* and *L. C. Crawford;* WITH A SUPPLEMENT INCLUDING ADDITIONS AND CHANGES THROUGH SEPTEMBER 30, 1938, *W. S. Eisenlohr, Jr.* (Coop. U.S.D.A. et al.) U. S. Geol. Survey (Washington), Water-Supply Paper 847 (1940), pp. III+272, fig. 1. This report is a compilation of the highest known discharges at most gaging stations in the United States and at several places on boundary streams in Canada and Mexico. The principal value of these data is considered to lie in the fact that in the design and operation of a variety of engineering works on rivers, such as dams, spillways, bridges, dikes, and floodways, it is important to know the flood flows for which provision should be made. This report summarizes the records of flood discharges of the streams of the United States for several thousand drainage areas. Many of the records cover scores of years. A few go back more than 100 years.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE IOWA STATION. (Partly coop. U.S.D.A.) Iowa Agrl. Exp. Sta. (Ames) Rpt. 1940, pt. 2, pp. 11-14, 18-19, 20-22, fig. 1. This report notes work on soil erosion on the Marshall silt loam in Page County, by W. H. Pierre, G. B. MacDonald, J. B. Davidson, and H. D. Hughes; trials of the basin method of planting corn on representative soil areas of Iowa, by Davidson, E. V. Collins, H. R. Meldrum, and G. F. Sprague; efficiency of corn pickers, by C. K. Shedd, Davidson, and Collins; seedbed preparation for corn, and corn-production methods and equipment, both by Davidson, Collins, and Shedd; storage and curing of corn, by H. J. Barre, Davidson, and J. L. Robinson; and investigation of farm storage of corn, by Davidson, Barre, and G. Semeniuk.

A RANGE SHELTER WITH GALVANIZED IRON ROOF, *D. C. Kennard* and *V. D. Chamberlin*. Ohio Ag. Exp. Sta., Wooster. Bimo. Bul. 209 (1941). The authors briefly describe the construction of a 10x12 ft shelter differing from those previously designed at the station in that it is roofed with corrugated galvanized iron. The shelter is dimensioned for from 100 to 125 pullets and may be moved on removable skids or by loading onto a wagon or truck. Six roosts run lengthwise.

A NEW PORTABLE COLONY BROODER HOUSE, *D. C. Kennard* and *V. D. Chamberlin*. Ohio Ag. Exp. Sta., Wooster. Bimo. Bul. 209 (1941). The use of corrugated 28-gage galvanized iron roof and siding served to decrease the weight of a 10x12-ft house by 500 lb as compared with the use of lumber. A gable roof with side walls 4 ft high decreased the space inside 9 per cent as compared with that of a house with a shed roof 5 ft high in the rear and 7 ft high in front. Durability and minimum original and maintenance costs were primary objectives in the design described. Plans and bills of materials for this and for the structure described in the article above noted are available from the station.

AGRICULTURAL ENGINEERING INVESTIGATIONS (WISCONSIN). Wisconsin Ag. Exp. Sta., Madison. Bul. 451 (1941). This report notes the third year of successful use of an experimental corrugated roller seeder which increased June stands of alfalfa by 66 per cent and those of timothy by 140 per cent as compared with dropping seed down the spouts of a grain drill. *(Continued on page 110)*

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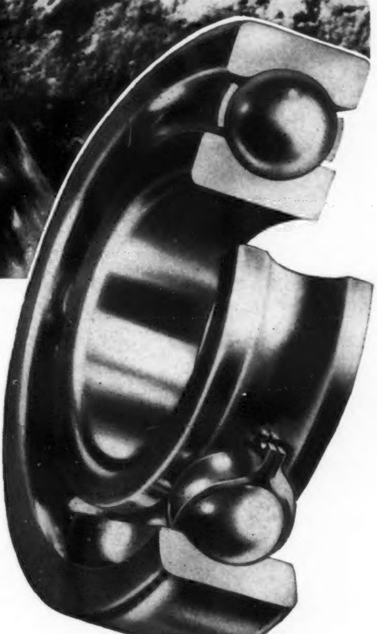

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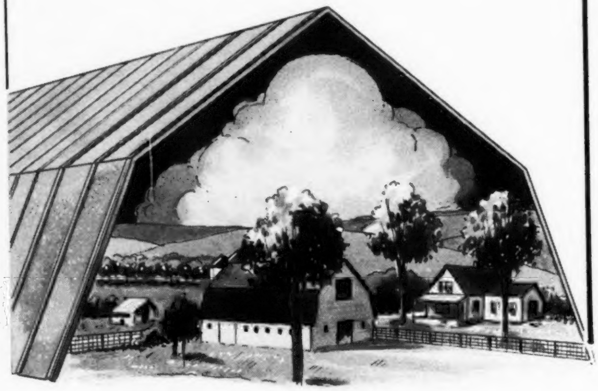

Agricultural Engineering Digest

(Continued from page 108)

ELECTRIC FENCE CONTROLLERS, WITH SPECIAL REFERENCE TO EQUIPMENT DEVELOPED FOR MEASURING THEIR CHARACTERISTICS, *F. A. Everest.* Ore. Engin. Exp. Sta. (Corvallis) Bul. 11 (1939), pp. 47, figs. 29. Noting the possible hazard involved in the general use of devices which energize great lengths of exposed conductor, the author notes that "before regulatory bodies can function effectively, they much have data on the physiological effects and lethal limits of various types of electric shocks and have available proper instruments for measuring the various electrical quantities involved." This bulletin is largely concerned with the necessary instruments, their design, and methods for their use.

Typical fence circuits are first dealt with, the energizing methods taken up being an inductive discharge, direct current and alternating current operated; continuous and intermittent alternating voltage; charged condenser, continuously or intermittently applied to fence; and the charged condenser relaxation circuit.

Theoretical considerations of the induction type of electric-fence controller include a mathematical analysis, transient solutions for current make and for current break, and mathematical expressions for quantity of electricity circulating in secondary circuit at current make and at current break.

A section on photography of random transients by means of the cathode-ray tube describes a trigger circuit. Measurement of the quantity of electricity in electric-fence controller impulses is taken up, a statement of the problem being followed by discussion of an integrator circuit. Voltage dividers for transient phenomena are considered, and a high-voltage, vacuum-tube voltmeter, involving use of the inverted vacuum tube as a voltmeter, is described.

For testing electric-fence controllers under conditions closely simulating those of actual operation, the author devised an instrument called an artificial fence. It is pointed out that the electrical parameters of a single fence wire strung at a constant height above the ground include a linear resistance, which may be taken as its entire impedance, self-inductance being treated as negligible. Leakage resistance across all insulators and grounded objects touching the wire, all being in parallel, are lumped as an equivalent single resistance. The capacitances between earth and incremental lengths of the wire are similarly summed as an equivalent capacitance. It is considered that the resistance of the wire is normally so low that it, as well as the self-inductance, may be neglected. The artificial fence, therefore, consisted of a series of parallel resistances giving a range of from 100 to 500,000 ohms and parallel condensers giving a range of from 0.003 to 0.079 μf, the entire range of the resistance and capacity of the instrument being equivalent to about 5.6 mi of fence.

New Literature

"PLANS FOR CONCRETE FARM BUILDINGS." Second edition revised, 8½x11 inches, 56 pages, illustrated. Portland Cement Association, 33 West Grand Ave., Chicago. The plans presented in this book are intended to provide ideas and suggestions for the proper design and construction of farm buildings of various kinds. The general plan of the book is to present essentials of quality concrete and sound building construction on the farm. More detailed plans in blueprint form are available free upon request to the Portland Cement Association of plans for various farm buildings shown in this book. The contents of the book includes instructions on how to make quality concrete, including footings, foundations, basement walls, floors, and masonry construction, and also including the insulation of concrete buildings. The plans for various structures featured in the book include general-purpose and dairy barns, milk houses and cooling tanks, poultry houses, hog houses, grain and other storages, cellars, greenhouses, water supply tanks, manure pits, etc., etc.

"MATHEMATICS IN AGRICULTURE" by R. V. McGee, department of mathematics, at A. & M. College of Texas. Cloth, 6x9 inches, 190 pages. $4.00. Prentice-Hall, Inc., New York, N. Y. The book is an effort to meet the demand for a practical book on mathematics designed especially to fit the needs of persons interested in agriculture. While the text is not meant to serve as an authoritative source on technical matter pertaining to agriculture, some technical matter has been included in an effort to vitalize the subject by giving to problems their proper agricultural setting. Also, the tables near the end of the book contain information which possesses practical value for anyone engaged in agriculture. The following subjects constitute the main chapter headings: Mathematical Operations, Percentage; Equations; Lengths, Areas, and Volumes; Ration and Proportion, The Right Triangle and Trigonometry; Averages; Graphs; Special Applications of Practical Measurements; Exponents, Logarithms, The Slide Rule, and about twenty pages of tables.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS OPEN

AGRICULTURAL ENGINEER wanted for farm structures research work in the agricultural experiment station of a southeastern college. Only a man with some research experience and not subject to immediate military service will be considered. Work will be primarily concerned with storage buildings. Good fundamental training with good scholastic records necessary. Salary up to $2,700 according to qualifications. PO-134

ENGINEERS needed by U. S. Government. The U. S. Civil Service Commission, Washington, D. C., has listed the following opportunities for engineering work for the federal government, of possible interest to A.S.A.E. members:

Technical Assistant (Engineering), $1,800 a year. Unassembled examination. Write for announcement No. 177.

Engineering Aide, photogrammetric and topographic options, $1440 to $2600 a year. Unassembled examination. Write for announcement No. 206.

Chemical Engineer (five grades), $2600 to $5600 a year. Unassembled examination. Write for announcement No. 163.

Copies of the announcements referred to may be obtained by writing direct to the Commission. They give full details concerning the positions, the requirements to be met, and where to obtain and file applications.

POSITIONS WANTED

AGRICULTURAL ENGINEER with experience in design and manufacture of farm machinery in small, medium, and large manufacturing concerns in the eastern and midwestern states. Reared on eastern Pennsylvania farm. Received B.S. degree at Pennsylvania State College in 1935. Desires position in development or production of farm machinery where past experience will be of value. Age 28. Married, one child. References on request. PW-347

AGRICULTURAL ENGINEER with B. S. degree in engineering and M. S. degree in agricultural engineering. Experienced in college teaching, experiment station, and extension work; also factory and construction work. Especially qualified for college agricultural engineering, manufacturing, defense, construction, or trade extension work. Age above draft. W-346

AGRICULTURAL ENGINEER with B.S. degree from midwestern college (1938) and M.S. degree from southern college (1940), desires employment with the Soil Conservation Service, in a defense industry, or in other engineering work. Has 1½ years' experience as engineer with the U. S. Soil Conservation Service in the South and in the Pacific Northwest. Familiar with agriculture in most parts of the United States. Civil Service rating as junior engineer. Eligible for reappointment. Age 35. Married. PW-345

AGRICULTURAL ENGINEER desires employment offering larger opportunity. Ten years' experience in the electric utility industry and two years' experience as an assistant extension agricultural engineer. Good farm background. Particularly qualified to handle all phases of rural electrification, pump irrigation, and farm machinery. Capable of planning and conducting educational or promotional activities. Holds a state professional engineering certificate. Thirty-six years of age. Married. References on request. PW-344

AGRICULTURAL ENGINEER with 15 years' experience in the farm equipment industry; knows both farmer and tractor and implement industry in all sections of world; especially Canada and U.S.; advertising, public relations, editorial, camera, radio; can direct a complete service for dealers and factory; knows governmental and agricultural college officials; Farm Bureau; boys' and girls' clubs, livestock and special crop associations. Will locate anywhere the right firm or industry may wish. Have production records that speak. Personal portfolio mailed on request. PW-343